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THE

# AMERICAN JOURNAL

OF

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## ERRATA.

Page 252, Title and elsewhere, for Santa, *read* Santo.
" " line 19, for Saybo, *read* Seybo.
" " line 6 from bottom, for Macorio, *read* Macoris.
" 253, line 4, for cone, *read* core.
" 254, line 5, for " *read* "
" " line 2, for Pterocardia, *read* Pteroceroid.
" " line 19, for Citao, *read* Cibao.
" " line 5 from bottom, for but were much folded, *read* but *nowhere* were much folded.
" 255, line 19, for north, *read* mouth.
" 285, line 4 from bottom, for $\frac{86}{100}$, *read* $\frac{36}{100}$.
" 294, line 14, for was, *read* were.
" " line 20, for outlines, *read* outliers.
" " lines 22 and 35, for Paraúquára, *read* Parauáquára.
" " line 27, after diorite, *insert* boulders.
" " line 28, for flanks of the serras, *read* flank of the serra.
" 295, line 22, for Para, *read* Pará.
" " line 27, for Almeyrine, *read* Almeyrine and Santarem.
" " line 28, after origin, *insert* deposited.
" " line 42, before they, *insert* as.
" " line 46, for —being, *read* bearing.

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# THE
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## [THIRD SERIES.]

## ART. I.—*On the Quaternary, or Post-tertiary, of the New Haven Region*; by JAMES D. DANA.[*]

### I. THE GLACIAL ERA AN ERA OF GLACIERS, AND NOT OF ICEBERGS.

IT is still a mooted question in American Geology whether the events of the Glacial era were due to *glaciers* or *icebergs*. Agassiz and Guyot, who were long among the most active of Alpine explorers, found on their arrival in New England only the effects of glaciers. But American geologists are still divided in opinion, and some of the most eminent have pronounced in favor of icebergs.

The region of New Haven is exceedingly well situated for settling the question, not only as regards its immediate vicinity, but for the whole interior of New England. For in the first place, the region is a wide and open area at the southern termination of the Connecticut Valley;[†] and this valley is the great central valley of New England, including the larger part of its surface outside of Maine, the Green Mountains making its western border, and the White Mountains and the height of land southward, its eastern. Then secondly, the valley has a north-

---

[*] The principal facts relating to the New Haven Quaternary, which I propose to bring out in the article here begun, are included in a paper by the author on the Geology of the New Haven region, published recently by the Connecticut Academy, in volume II, of their Memoirs.

[†] The Connecticut Valley has a general course from north to south, varying little from S. 9° W. It is occupied by the Triassic (or Triassico-Jurassic) Red sandstone formation from New Haven to northern Massachusetts, and this indicates the position which it had in the Mesozoic era. The Connecticut river leaves the valley at Middletown, taking there a southeasterly course among the metamorphic rocks of the eastern half of Connecticut.

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and-south course; so that, whether glaciers or icebergs were the agents, it would, in either case, have guided their great movements, and the New Haven region would have necessarily become filled with registers of the successive events. Being situated on an arm of the Sound, and at the same time extending inland for seven or eight miles along three streams that here have their discharge, the phenomena presented comprise results from both the sea and the rivers, and also from their combined action. On these several accounts, the New Haven region is eminently well situated for deciding the glacial question for all central New England.

A special study of the region during the last two years has led the writer to the conclusion that the effects are solely those of glaciers, or rather, of a *Connecticut valley*, or *Central New England, glacier.** To exhibit all the evidence bearing upon the question would require a full discussion of the whole range of facts presented by the New Haven Quaternary. I propose at this time to mention only a few of the more trenchant and decisive points.

The question is—Was the interior of New England in the Glacial era covered by a sea at least 4,000 feet deep for the floating of icebergs; or, was it emerged land as now, (perhaps to a higher level than at present) and submerged only beneath ice, the ice of an immense glacier, 3,000 feet and less in thickness, the ice in Vermont and New Hampshire being 4,000 feet and more above the level of the sea?

1. The sea, if it covered the land in the Glacial era, should have left proof of it along the southern coast of New England.

About New Haven, the height of the stratified Quaternary deposits above the sea (Long Island Sound), or above the river flats, no where exceeds 50 feet. This is the maximum; the particular facts will be stated at another time. Fifty feet is therefore the greatest amount of depression of the land which is indicated, the greatest that can be admitted by those who base their geological conclusions on facts. There are no traces of sea beaches or any thing corresponding thereto at a higher level. On passing the level of 50 feet above the Sound there is an abrupt transition from the stratified to the unstratified drift, except along the courses of streams, and near these, there is the same transition on passing the level of 50 feet (or less) above the existing river flats.

The highest sea-level of the Quaternary era about the New Haven region is thus definitely marked. It is often assumed that the *unstratified* drift might have been dropped over the hills by icebergs; but, as Mr. Croll has recently urged, depositions in water cannot be made without stratification. The slightest jar of a vat of water holding sediment suspended will cause that sediment to go down in a laminated state; and so deposits of sands and gravels in the ever moving sea will always manifest their aqueous origin. The stratified and unstratified material about New Haven therefore mark the limit between aqueous and dry-land deposition. Much has been said about "modified drift," or more or less stratified drift deposits, over the hills; but they occur no where, according to my observation, except along water courses or about the sites of old lakes; they sustain the conclusion that the unstratified drift was essentially a dry land deposition.

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* The existence of essentially independent glaciers, (under the continental Glacier) in the Glacial era was recognized by the author in an article in this Journal, vol. xxxv, p. 243, 1863, and in his Manual of Geology, p. 763, published about the same time; and four great glaciers were there particularly mentioned, the Connecticut River, the Penobscot, the Hudson River, and the Mohawk River.

2. The magnitude, wide distribution, and regularity of direction in the scratches are evidences against Icebergs.

This is no new argument; yet it has lost nothing of its force by long use. Broad furrows, eight to ten inches in depth, made in trap or granite over long distances, uniform in direction, must have required prolonged abrasion for scores of years, and by an abrading agent not liable to change of course through tides or currents, or to changes of form and thereby of center of gravity from waste in the waters over the rocks. Glacial abrasion has been found so generally wherever the soil has been freshly removed that it may be safely inferred, as has been done for other parts of New England, that the abrasion was universal. Passing from the New Haven region westward, over the high plateau of Litchfield, Warren, etc., 1000 to 1500 feet in height above the sea, the scratches have the same uniformity and wide distribution. Grounded icebergs would be sufficient for such results only in case they spread completely over the wide surface and rested firmly upon its every part,—in which case they would be nothing less than partly submerged glaciers.

3. The scratches are, in some cases, in such positions that only a glacier could have produced them.

For example: on Mount Carmel—an east-and-west ridge in the Connecticut valley depression, about 750 feet in height, nine miles north of New Haven—along one of the steep southern valleys, the surface of trap (dolerite) is extensively abraded, and marked with many large and broad north-and-south furrows. An iceberg, moving southward, which could float over the top of Mount Carmel ridge would not touch bottom in this southern valley, for the part eroded is at least 150 feet below the level of the ridge to the north of it. While this erosion is, therefore, beyond the capacity of icebergs, it would be the natural result of a Connecticut valley glacier.

4. Since icebergs are fragments of glaciers broken off by the sea into which they descend, and since their freight of stones is part of the moraines of the old glacier, the boulders of the New Haven region, and of New England generally, should, on the Iceberg hypothesis, be the rocks of the White Mountains (whose highest peak, Mt. Washington (the loftiest in New England) is 6288 feet high), or of some Green Mountain Peak (over a thousand feet lower), if not from some more distant northern source.

But, in fact, the boulders about New Haven have come mainly from the central part of Connecticut and Massachusetts, and largely from the hills or ledges in the Connecticut valley itself; and not from any mountain summit or ridge either side. They are therefore from *the bottom* of the alleged Iceberg sea, and not from any emerged summits.

These boulders are masses of trap 1000 tons in weight and less; and Mt. Tom and Mt. Holyoke, situated adjoining the Connecticut river in Massachusetts, seventy miles north of New Haven, are the most northerly points from which such masses could have come. The tops of these so-called mountains would have been over 2600 feet below the surface if the Iceberg sea were 4000 feet deep. Other boulders are of the Triassic red sandstone; and these also had their origin *in the Connecticut valley*, south of the northern limits of Massachusetts, for none exists farther north. Others, of large size, some of them ten to fourteen feet in length, are of gneiss and came from a gneiss region, either in northern Connecticut, ten to twenty miles west of the Connecticut river, or just north of this in the adjoining part of Massachusetts. Again, six to eight miles west of New Haven, there are numerous large boulders of porphyritic gneiss, which were derived from ledges less than thirty miles distant to the north or northwest.

The facts show, beyond question, that in the Glacial era, the transported blocks came from the comparatively low regions, in the very bottom of the supposed Iceberg sea, not far to the north of New Haven, instead of from distant and elevated heights to the northeast or northwest; and this was true of all the drift material. The observations of others over New England, as well as those I have made over Connecticut, sustain the conclusion that the sand and gravel of the unstratified drift has not come from remote points, but has been shoved southward by some agent that could gather it up over the breadth of the land and bear it onward to drop it after a few miles, or scores of miles of transportation. All this is evidently impossible work for icebergs.

Since, then, icebergs cannot pick up masses tons in weight from the bottom of a sea, or give a general movement southward to the loose material of the surface; neither can produce the abrasion observed over the rocks under its various conditions; and inasmuch as all direct evidence of the submergence of the land required for an iceberg sea over New England fails, the conclusion appears inevitable that icebergs had nothing to do with the drift of the New Haven region, in the Connecticut valley; and, therefore, that the Glacial era in central New England was a *Glacier* era.

## ART. II.—*On the Corona seen in total Eclipses of the Sun;* by Professor W. A. NORTON.

IN a communication to the Sept. No. of this Journal, I alluded briefly to the auroral theory of the solar Corona, and referred to publications in which I had advocated it. I propose now to give a brief discussion of the theory.

The grounds upon which I have maintained the auroral origin of the Corona in different publications are the following:

1. The Corona cannot be the permanent atmosphere of the sun, shining by reflected light, since its outline is neither circular nor oval, but exceedingly irregular, and it extends out from the sun many times farther in some directions than in others. The utmost that can reasonably be maintained is that for a small portion of its outward extent, for which the gradation of light is nearly uniform, it may possibly be a solar atmosphere.

2. The natural indications of the aspect of the corona are that it is chiefly composed of separate masses of luminous matter, of unequal brightness and length, radiating out from different points of the sun's limb. The general radiated structure of the corona, and the great comparative outward extent of the luminous radiations in certain directions, have attracted the attention of the observers of all modern eclipses. Some streamers have been seen to extend more than 1,000,000 miles from the sun, while others did not extend to one quarter of this distance.

3. Reasoning analogically from the earth to the sun we naturally conceive the body of the sun to be surrounded by a permanent atmosphere. On the same grounds we should infer that the space exterior to this atmosphere is pervaded, either occasionally or permanently, by auroral streamers, similar to those which at times shoot out many hundreds of miles into space, from the upper atmosphere of the earth.

4. If the luminous radiations of the corona are in fact auroral streamers, we must expect that they will not be permanent in their extent and position. Now it is well known

that such is the fact, for the aspect of the corona has been very different in different eclipses (e. g. eclipses of 1842, 1851, 1858, and 1860). It has even been maintained by some observers that the rays of the corona had a flickering luster, and varied in extent and position during the short period of a single eclipse.

5. Admitting, as we must, the actual radiated structure of the corona, its individual streamers, or luminous radiations, may be conceived either to be permanently connected with the sun, or to be composed of luminous matter actually streaming away from the sun, to an indefinite distance, into space. If we adopt the former idéa, we virtually admit that a permanent vaporous atmosphere of sensible density extends from the body of the sun to a distance greater than the sun's diameter, a position that cannot with any plausibility be maintained.* In support of the other hypothesis we have the well established fact that some form of luminous matter, belonging to cometary bodies, when it comes under a certain degree of influence from the sun, is projected or in some manner detached from the nùclei of these bodies, and repelled from the sun, and under the operation of the solar repulsion urged away from them to an indefinite distance, forming the luminous trains by which they are attended. (See the author's papers on Donati's Comet published in this Journal, Jan. and May, 1860, and July, 1861; and the discussion of the Dynamical Condition of the Head of a Comet in the No. for Jan., 1859). To suppose that the rays of the corona are actual radiations of luminous matter, is only to suppose that a portion of the photospheric matter of the sun becomes subject to the operation of the same forces, that we perceive the sun to exert upon a portion of the matter of comets. The luminosity of such radiations may be ascribed either to a reflection of the sun's light, or to electric discharges. Upon this question we shall see important evidence was obtained at the total eclipse of Aug. 7, 1869.

6. If we adopt the auroral theory of the corona, and at the same time admit that the auroral streamers are actual emanations of luminous matter, the following consequences may be expected to follow.

(1.) A portion of the auroral matter emitted from the sun should fall upon the earth's atmosphere, and may furnish the substance of terrestrial auroras, for which no terrestrial origin has yet been detected.

(2.) Upon this view of the possible origin of terrestrial auroras, the close correspondence that has been detected between the periods of the sun's spots and of auroras, should subıt if we allow that the spots are merely the natural result of e supposed discharges of the solar matter, prevailing for a ne at certain points of the photosphere; or indeed if we grant at they are in any way the result of these discharges visible the corona.

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* According to the recent spectroscopic determinations of Lockyer and Frankland, the solar atmosphere must be of exceeding tenuity in the region of the rose-colored protuberances just above the general surface of the chromosphere.

(3.) In the wave propagation of the impulsive actions on the her of space, of the electric discharges to which we may ascribe e material emanations from the photosphere, and in the elec- ic and magnetic phenomena attendant upon the reception and cumulation of the solar auroral matter in our atmosphere, we ıve a plausible general explanation of the periodic and irregu- r disturbances of the magnetic condition of the earth, and of eir known physical relations to the sun's spots. This theory the origin of the diverse perturbations of terrestrial magnet- m I have elaborated, and followed out into a detailed discus- on of the variations of the different magnetic elements in rmer Nos. of this Journal (viz: for March and July, 1855). We may add that it derives additional support from the gene- l result arrived at by Prof. Chambers, in his discussion of the Nature of the Sun's Magnetic Action," viz: that "the mode in hich forces originating in the sun, influence the magnetic con- tion of the earth, is not analogous to the action of a magnet ›on a mass of soft iron placed at a great distance from it, but at these forces proceed from the sun in a form different from at of magnetic force, and are converted into this latter form force probably by their action upon the matter of the earth its atmosphere." If this be admitted then we must conclude at the perturbations of the earth's magnetic condition, as inced by the variations of the position and directive force the magnetic needle, must result either from some action ect or indirect on the earth or its atmosphere, of some form matter emitted from the sun, or from a wave-action propa- ıted from the sun, or from both of these operative causes mbined.

(4.) The streamers of the corona should have at different ints of the sun's photospheric surface different directions, rallel to the diverse directions of the magnetic force of the n at this surface. These directions should be variously in- ined, in different heliographic latitudes, to the horizontal lines the points of the surface, and also to the plane of the sun's uator; like the dipping needle on the earth and the streamers a terrestrial aurora. In low latitudes the angles of inclina- on to the plane of the equator should be large, and the streamers oceeding from corresponding points in the two hemispheres, ould converge and intersect in the plane of the equator. In oportion as these corresponding streamers proceed from ints more remote from the sun's equator, they will intersect under a smaller angle, and their point of intersection will be more distant from the sun's surface; until at the heliographic latitude of 30° to 35°, they will become parallel to the plane of the equator. Those emanating from still higher latitudes will diverge from the plane of the equator and from each other.*

If these facts be attentively considered it will be seen that the result should be the formation of a luminous appearance extending indefinitely outward from the sun into space, and elongated in the plane of his equator; and that to observers on the earth it would have an apparent form more or less triangular.

The same fundamental conception which accounts for the solar corona, and the physical relations known to subsist between the sun's spots and terrestrial auroras, as well as between these spots and the varied magnetic disturbances occurring on the earth, furnishes then an adequate explanation of the extent, form, and position of the *Zodiacal Light.* In fact we see that the zodiacal light is but the indefinite extension of the corona.

We have here tacitly supposed that the solar emanations consist of magnetic matter projected with great velocity into space, in the directions of the prolongations of the auroral columns, and proceeding on indefinitely in these directions; but if, like the cometic matter, they are exposed to a continual repulsion from the sun, the paths described by the receding particles would be hyperbolas convex toward the sun. The point of intersection of any two streamers proceeding from corresponding low latitudes in the two hemispheres, would in consequence be thrown to a greater distance from the sun, but the general result as to the form and position of the luminous appearance produced, (the zodiacal light) would be the same.

In support of this view of the origin of the zodiacal light we may state that Cassini drew from his observations on the sun's spots and the zodiacal light, made during the interval from 1665 to 1688, the conclusion that a physical connection subsisted between these two phenomena, and that the substance of the zodiacal light was in fact some emanation from the sun's spots. Again, according to Arago, it appears from the entire series of observations at Paris and Geneva, that the zodiacal light varies considerably from one year to another, and that the observed variations cannot result entirely from changes in the transparency of the atmosphere. We shall soon see that the form of the corona, as seen in the eclipse of 1869, and previous eclipses, presented certain prominent features that accord with the theoretical conclusion that the zodiacal light is but the indefinite extension of the corona.

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* It is here assumed that the magnetic equator of the sun is coincident with his heliographic equator.

It is proper to state here, that in what precedes we have really been contemplating but different sides of one comprehensive theory, which embraces a connected series of solar phenomena, of which the corona is but one term. The outline of this theory is given in the author's Treatise on Astronomy, revised edition (1867). It is that a portion of the matter of the sun's photosphere is in the habitual condition of auroral magnetic columns; that by electric discharges along these columns, their substance becomes dispersed and in part projected into space; and that this process, wherever occurring, may by a continued dissipation of a portion of the photospheric matter at that locality, eventuate in the formation of a visible spot on the disc; that the photospheric matter thus discharged into space, is in that peculiar condition recognized in cometic matter in which it becomes subject to a repulsive action from the sun (or else to a diminished attractive action, as occurred to a certain extent in the case of Donati's comet, and in that of 1861), and in the act of flowing away is visible in solar eclipses as the streamers of the corona, and at more remote distances as the zodiacal light; that these solar emanations furnish the matter of terrestrial auroras, and when descending in copious showers into the earth's atmosphere, and developing electric currents and disturbing the magnetic condition of the earth, are the determining cause of all the phenomena of "magnetic storms." The apparent structure, and variability of the corona, and, as we shall soon see, the most characteristic features of its form, the form, position, and variability of the zodiacal light, the coincidence of the periods of the sun's spots with the periods of terrestrial auroras, and with those of the perturbations of the magnetic needle, all accord with this general theory. I have also endeavored to show in my papers on the variations of the magnetic elements, that these variations are such as should naturally result from the electric currents in the upper atmosphere, (or what may be called the photosphere of the earth), that would ensue from the reception of the supposed impulsive waves, and material emanations proceeding from the sun. (See this Journal, II, vol. xix, March and July, 1855).

If it indeed be true, that from the fundamental conception of material emanations from the sun similar to those which we know to take place from the head of a comet under the influence of the sun, a connected series of phenomena may be theoretically deduced which have their actual counterparts in Nature, it must be conceded that there is a high probability that this conception is founded in truth, and furnishes the true explanation of the varied phenomena observed.

on either side of this plane, and in consequence the corona should appear to extend farther in the plane of the equator, than in other directions. The convergence of individual rays or lines of emanation, we have already seen, was actually noticed by Professor Eastman. It of course may happen that inequalities in the amount of outstreaming on opposite sides of the equator, may throw the more prominent and conspicuous parts of the corona to the one side or the other of the plane of the equator. It will be observed that from our present point of view, the extension of the corona in the plane of the sun's equator is a phenomenon kindred to the much greater luminous extension seen in the zodiacal light; the only difference between them being, that in the former the auroral emanations proceed from lower heliographic latitudes, and intersect nearer the sun.

But it may be asked how are we to explain, on the present theory, the "star points" of the corona over the polar regions of the sun. For these, two reasons may be assigned. (1) If we admit a distribution of magnetism on the sun similar to that which prevails on the earth, the auroral streamers should diverge from each other less rapidly in the high than in the low latitudes. (2) Upon opposite sides of a line of no declination traversing the sun's surface, analogous to that which traverses Russia, the natural directions of the streamers prolonged upward would be such as to occasion the convergence and intersections of those proceeding from the opposite sides of this line.

We may say then that the more extended portions of the corona, in the eclipse of 1869, were over those regions of the sun's surface, and those only, where upon the present theory the intersections of streamers might be expected to occur.

In some eclipses distinct luminous curves having the appearance of luminous jets issuing tangentially to the sun's limb, or obliquely inclined to it, and pursuing a course either convex or concave to the limb, have been seen. According to M. Liais these peculiarities were conspicously observable in the eclipse of Sept. 7, 1858. While it is possible that such curves may be the result of the intersections of a mass of straight streamers, it is not improbable that they may be actual luminous jets; for if from any cause any portion of the auroral matter should be projected from the sun in a direction oblique to the surface, it would proceed in a convex hyperbolic curve if repelled by the sun, and in a concave curve if attracted. Now I have shown in a former No. of this Journal (July, 1861), that the portion of cometary matter posited on the convex side of the tail of Donati's Comet was actually repelled by the sun, while that on the concave side had become detached from the head of the comet, because of a diminished gravitation toward the sun. Upon our fundamental conception that the coronal matter is essentially in the same physical condition as such cometic matter, and subject to the action of the same solar forces, it may well happen that some individual jets will proceed in convex, and others in concave curves, according as the escaping matter is repelled or attracted by the sun.

2. *Observations on the physical constitution of the corona with the Spectroscope and Polariscope.*—The results of the observations made at the late eclipse, with the spectroscope and polariscope, are strongly confirmatory of the truth of the theory of the corona under discussion. Professor Pickering in the Report of his observations with a polariscope, says, "The form of polariscope used was that adopted by Arago in his experiments on sky polarization. It consists of a tube about twenty inches long and two inches in diameter, one end of which is closed by a double image prism of Iceland spar, and the other by a plate of quartz. Looking through the former we see two images of the latter, which when the light is polarized assumes complementary tints. If, now, the corona was polarized in planes passing through the center of the sun (as is generally admitted), when viewed through the polariscope, in one image the upper and lower parts should have appeared blue, and those on the right and left yellow; while in the second image these colors would be reversed, the yellow being above and below, and the blue on the sides. In reality the two images were precisely alike, and both pure white, but one was on a blue and the other on a yellow back-ground. From this we infer that the corona was unpolarized, or, at least, that the polarization was too slight to be perceptible."

We may infer from this that the corona is either self luminous or shines by diffuse reflection; since specular reflection produces polarization.*

The testimony of the spectroscope is still more decisive. Profs. Pickering, Harkness, and Young, agree that the spectrum from the light of the corona was a continuous one, or free from dark lines; but containing one or more bright lines. The absence of dark lines indicates that the corona did not shine by the light of the photosphere, reflected either diffusely or specularly from its substance; since such light, after reflection, should, like the direct solar light, have given a spectrum with the Fraunhofer lines. The presence of bright lines, on the other hand, is a direct indication that the corona was self luminous; and therefore that its light was the result either of combustion or of electric discharges. As it is hardly supposable that an actual combustion could prevail at the distance of tens, and hundreds of thousands of miles from the sun's photosphere, in regions where, if any solar atmosphere exist, the results of recent observations with the spectroscope by Lockyer and Frankland lead us to believe that it can only be the faintest possible trace of it, we must infer that the light of the corona is of electric origin.

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* The question whether the light from the corona is in any degree polarized or not cannot be regarded as definitively settled. It is to be hoped that the observations to be made on the eclipse of December will remove all doubt on this point.

In the hands of Prof. Young and Prof. Winlock the spectroscope has obtained direct evidence of a physical correspondence between the solar corona and terrestial auroras. Prof. Young observed in the spectrum of the corona a bright line the position of which he gives as 1474 on Kirchoff's scale, and which proves to be in coincidence with a small line marked as *iron* on Kirchoff's and Angström's maps. He remarks that "it turns out also to coincide very closely if it is not (which is much more probable) absolutely identical with a line recently discovered by Prof. Winlock of Cambridge, in the spectrum of the aurora borealis. He also saw two other fainter lines in the spectrum of the corona which coincided quite closely with other lines reported by Prof. Winlock as visible in the spectrum of the aurora. In view of these results of spectroscopic observation he remarks, as follows: "At present it seems pretty likely that the spectra of the corona and the aurora borealis are identical, with only such differences in the intensity of their lines as we might naturally expect, and that very probably the identity extends to the essential nature of the phenomena themselves."

The detection of the same iron line in the aurora and corona, taken in connection with the well established fact that the vapor of iron is present in the photosphere and chromosphere of the sun, and that the magnetic features of the aurora lead to the natural conclusion that some form of ferruginous matter constitutes the substance of auroras, for which no terrestrial origin can reasonably be assigned, conducts to the inference that the terrestrial auroral matter is derived from the sun, and adds to the weight of accumulative evidence in support of the theory I have advocated that the corona is made up of material emanations from the sun.

NOTE.—Some persons have conjectured that the corona might be produced by the passage of the sun's rays through the earth's atmosphere, but it may readily be shown that this is impossible. When one reflects that the half width of the moon's shadow, in the larger eclipses, is as great as the estimated height of the atmosphere, it will be seen that, to an observer on the central line of the eclipse the line of sight will not fall upon the illuminated portion of the atmosphere exterior to the shadow, unless inclined under a large angle to the line of direction of the centers of the sun and moon. The corona, therefore, if of terrestrial atmospheric origin ought to present, toward the middle of the eclipse, the appearance of a halo *entirely detached from the dark body of the moon, and many degrees distant from it.* It ought also to increase in brightness from its inner border, for a considerable distance outward.

Others have imagined that the corona might be attributable to the passage of the sun's light through a lunar atmosphere; but since some of the streamers, or rays of the corona, have been seen to extend to a distance greater than the sun's diameter, this would require the lunar atmosphere to be of vast extent; whereas no decisive evidence has yet been obtained of the existence of any lunar atmosphere capable of producing a sensible refraction, or reflecting a perceptible amount of the sun's light to an observer on the earth.

Perhaps the more prevalent idea, at the present day, is that the corona, with its rays and tufts of light, is a phenomenon of diffraction produced by the passage of the sun's rays along the denticulated edge of the moon. This theory has an air of plausibility, but it is entirely inadequate to account for the great extent of the coronal rays. The fringes produced by the diffraction of light in its passage near the edge of a body appear to the eye of the observer to extend but a small angular distance from the edge. This would be more strikingly true in the case of a distant body, like the moon.

The only remaining supposition is that the corona is either an envelope of some kind permanently connected with the sun, or is made up of material emanations proceeding immediately from the sun. To the large body of indirect evidence *that the corona is wholly a solar phenomenon* that has been obtained, we may now add that of direct observation, since it appears that "an examination of the photographs of totality," obtained at the eclipse of 1869 shows that as the moon advanced the corona was progressively covered.

## Art. III.—*On the Duration of Flashes of Lightning*; by O. N. Rood. (From a letter to Dr. W. Gibbs.)

After the completion of my first set of experiments on the duration of the discharge of a Leyden jar, I became anxious to make some measurements of the duration of a flash of ordinary lightning, which may be considered as equivalent to the discharge of an immense jar with an enormous striking-distance. The results of Feddersen have shown that the duration of the discharge is increased by an addition to the size of the jar, as well as by augmentation of the striking-distance, and as both these quantities are so large with a flash of lightning, it was reasonable to expect that the duration of its discharge would be prolonged in some corresponding ratio. During the violent thunder-storm of last August, which occurred in the evening, I happened to be at a house commanding an unobstructed view of the horizon, and this circumstance taken in connection with the frequency and proximity of the electrical discharges, induced me, although entirely unprovided with apparatus, to attempt a measurement of their duration. A circular disc, five inches in diameter, was hastily cut from white cardboard, while a steel shawl-pin served as an axis, on which it was made to revolve by constantly striking its edge tangentially with the right hand, the pin being held in the left. The *maximum* velocity attainable in this way was always employed. The general indications at the time were that the rate thus obtained was considerably more uniform than might have been expected, and subsequent quantitative experiments have confirmed this idea. The first experiments were made by observing black figures traced near the circumference of the disc, which was illuminated solely by the rapidly recurring flashes, and it often happened that the figures, with their details, were seen quite as clearly and sharply as though the disc had been stationary; on the other hand, sometimes the edges seemed blurred, as though the disc had moved through a few degrees during the act of discharge. The result being doubtful, the mode of experimenting was quickly changed; about fifteen narrow radial apertures were made near the circumference of the disc, and the flashes and illuminated clouds were observed through these openings, the disc being made to revolve as before. The distance of the eye from the apparatus was about eight inches, and it was of course adjusted so as to obtain distinct vision of the disc. The result was that sometimes the openings were seen quite unchanged in appearance, but more frequently they were most distinctly elongated into well defined streaks some degrees in length. They were observed often and without difficulty, but as farther confirmation I may add that I requested Prof. Joy, who was ignorant of the actual form of the aperture, to state his opinion of their apparent shape while the disc was in rotation. The reply was that they resembled Prince Rupert's drops—a not unfair description of the phenomena in question. Repeated estimates of their size were then made with paper and pencil. Some time afterward I measured the velocity which I could communicate to this disc in the manner above described, by attaching to it a small hollow axis through which the steel pin passed, the disc being then caused to wind up a thread stretched by a small weight. The rate of rotation thus attainable was found to be about twelve revolutions per second, which is a little more than I had anticipated. The average size of the streaks was 9°, corresponding to a duration of $\frac{1}{480}$ of a second. It hence results that the duration of the flashes of lightning on the occasion referred to was in round numbers about $\frac{1}{500}$ of a second, some of them, however, seeming to be confined to smaller limits.

I know of only a single circumstance which might militate against the correctness of the above conclusion, and it is but fair to give it such weight as it may carry. Becquerel has succeeded with some difficulty in observing a faint phosphorescence when an electric discharge is passed through rarefied air, and it is not absolutely impossible that the effects observed by me were due to a cause of this kind.

This point can hereafter readily be decided by observing with a revolving disc, not the distant clouds, but a sheet of white paper, placed so as to receive the light from the electrical flashes.

Columbia College, Nov. 10th, 1870.

## ART. IV.—*On the physical condition of a closed circuit contiguous to a permanent and constant Voltaic current; or, on "the electro-tonic state;"* by ALFRED M. MAYER, Ph.D.

IN 1831, after Faraday had made his brilliant and unequaled discoveries of Voltaic and magnetic induction, he gave, in his first series of experimental researches, a section on a "New electrical State or Condition of Matter;" which he designated as the *electro-tonic* state. This can, in a few words, be explained as a certain state of electrical tension produced in a closed metallic circuit by the proximity of another circuit, through which circulates an electric current. The latter circuit being broken, this tension evinces itself in producing, during its disappearance, an electric wave in the closed circuit, similar in character, but opposite in direction, to the one produced on forming the contiguous electric current.

Faraday, with his habitual philosophic reserve, hesitating to give a formal enunciation of any hypothesis as to the electrical or molecular condition of the wire during this state, says, (Exp. Res. 71) "this peculiar state appears to be a state of tension, and may be considered as *equivalent* to a current of electricity, at least equal to that produced either when the condition is induced or destroyed." But in the celebrated Bakerian lecture which he delivered in Jan., 1832, he reluctantly releases his mind from this opinion, and says, (Exp. Res. 231; 242), "The law under which the induced electric current excited in bodies moving relatively to magnets, is made dependent on the intersection of the magnetic curves by the metal being thus rendered more precise and definite, seem now even to apply to the cause in the first section of the former paper; and by rendering a perfect reason for the effects produced, take away any for supposing that peculiar condition which I ventured to call the electro-tonic state. * * * * Thus the reasons which induce me to suppose a particular state in the wire have disappeared; and though it still seems to me unlikely that a wire at rest in the neighborhood of another carrying a powerful electric current is entirely indifferent to it, yet I am not aware of any distinct *facts* which authorize the conclusion that it is in a particular state."

In Dec., 1834, however, we see with what reluctance he gave up his first opinion, for he thus writes (Exp. Res. 1114) in reference to "the influence by induction of an electric current on itself, and on the inductive action of electric currents generally." "Notwithstanding that the effects appear only at the making and breaking of contact, (the current remaining unaffected, seemingly, in the interval), I cannot resist the impression that there is some connected and correspondent effect produced by this lateral action of the elements of the electric stream during the time of its continuance. An action of this kind, in fact, is evident in the magnetic relations of the parts of the current. But admitting (as we may do for the moment) the magnetic forces to constitute the power which produces such striking and different results at the commencement and termination of a current, still there appears to be a link in the chain of effects, a wheel in the physical mechanism of the action, as yet unrecognized." Again, in 1838, (Exp. Res. 1661) he recurs to the idea of the electro-tonic state, in speaking of "the transverse effect of a current;" and in his "Relation of the electric and magnetic forces" (Exp. Res. 1729) he states, "It appears to me possible, therefore, and even probable, that magnetic action may be communicated to a distance by the action of the intervening particles, in a manner having a relation to the way in which the inductive forces of static electricity are transferred to a distance; the intervening particles assuming for the time more or less of a peculiar condition, which, (though with a very imperfect idea) I have several times expressed by the term *electro-tonic state.*"

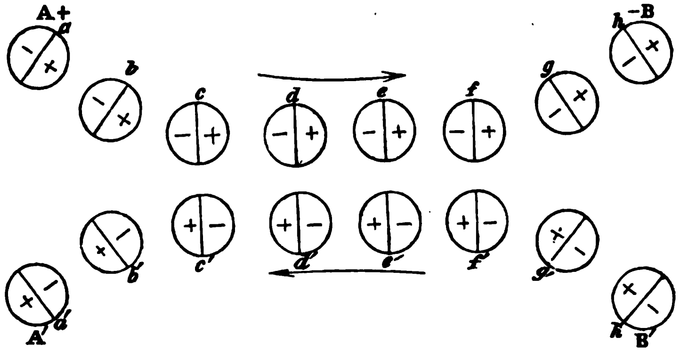
As late as 1851, Faraday yet hopes that future research may verify his idea of the electro-tonic state, for in his paper "on the lines of magnetic force," after having shown the relation of the magneto-electric current to the electro-conducting power of the substance in which it is induced, he writes (Exp. Res. 3172–73), "All the results described are those obtained with *moving metals.* But mere motion would not generate a relation, which had not a foundation in the existence of some previous state; and therefore the *quiescent* metals must be in some relation to the active center of force, and that not necessarily dependent on their paramagnetic or diamagnetic condition, because a metal at zero in that respect, would have an electric current generated in it as well as the others. The relation is not as the attractions or repulsions of the metals, and therefore not magnetic in the common sense of the word; but according to some other functions of the power. * * * * * If such a condition be hereafter verified by experiment, and the idea of an electro-tonic state be revived and established, then, such bodies as water, oil, resin, &c., will probably be included in the same state; for the non-conducting condition, which prevents the formation of a current in them, does not militate against the existence of that condition, which is prior to the effect of motion. A piece of copper, which cannot have the current, because it is not in a circuit, and a piece of lac, which cannot, because it is a non-conductor of electricity, may have peculiar but analogous states, when moving across a field of magnetic power."

In his paper on the physical character of the lines of magnetic force, occurs this remarkable paragraph (Exp. Res. 3269): "The mutual relation of the magnetic lines of force and the electric axis of power has been known ever since the time of Œrsted and Ampère. This, with such considerations as I have endeavored to advance, enables us to form a guess or judgment, with a certain degree of probability, respecting the nature of the lines of magnetic force. I incline to the opinion that they have a physical existence correspondent to that of their analogue, the electric lines; and having that notion, am further carried on to consider whether they have a probable dynamic condition, analogous to that of the electric axis to which they are so closely, and, perhaps, inevitably related, in which case the idea of magnetic currents would arise; or whether they consist in a state of tension (of the æther?) round the electric axis, and may therefore be considered as static in their nature. Again and again the idea of an *electro-tonic* state has been forced on my mind; such a state would coincide and become identified with that which would then constitute the physical lines of magnetic force."

We see from the above extracts (all that refer to this subject) that Faraday never gave a formal statement of his conception of the physical condition constituting the electro-tonic state; but other electricians, including Weber, Neumann and A. De la Rive, have framed hypotheses, more or less probable, to explain this condition. The one most generally received, and indeed widely copied into existing treatises on physics, is that of A. De la Rive. (Traité d'Electricité, t. i, p. 445). I here give this in his own words; and will then describe certain experiments of precision, which I have made to test the truth of his hypothesis. This is the object of making this communication.

"Without having recourse to conceptions and calculations as profound as Weber and Neumann's, I think that we can consider induction as the result of the ordinary inductive decomposition of the natural electricity of each particle of the induced conductor, by the already separated electricities of each corresponding particle of the inductor. In order that this shall take place, we must admit that the propagation of the current takes place by a series of decompositions and recompositions of the electricities of the successive molecules, in the same manner as takes place with insulating bodies, (referring to Faraday's theory of inductive action).

"Let A B be a conductor traversed by a current in the direction from A to B; the successive particles of which it is composed have their natural electricity decomposed, the — turned towards A where is the positive pole of the apparatus, and the + turned towards B where is the negative pole. The electricities, as soon as they have been separated, combine from particle to particle, thus: the negative of *a* with the positive of the pole A, the negative of *b* with the positive of *a*, and so on to the positive of *h* which combines with the negative of the pole B.



This recomposition, which is instantaneous, is immediately followed by a new decomposition, and this by a recomposition, and so on. This succession of decomposition and of recomposition is so rapid, that there is always, as experiment shows, an electric tension in each particle of the conductor, so that we can consider that the state in which it is represented in the figure, which we will call *state of polarization*, is nearly permanent.

"Now let A'B' be a second conductor similar to the first, as near to it as possible, and insulated with silk or wax. At the moment we pass a current in A B, and where consequently we polarize its particles, we produce in A'B' an opposite molecular polarization, the + of each particle being opposite the − of each particle of A B and the − before the +. It thereby follows that if, at the moment when A B is traversed by a current, the two extremities of A'B' are united by a conductor, such as the wire of a galvanometer, the + of the molecule *a'* combines, through this conductor, with the − of the molecule *h'*, and this produces an instantaneous current directed from A' to B' in the conductor, and from B' to A' in the wire A'B' itself, that is to say in a direction contrary to the inducing current. Also, if instead of being united by a conductor, the extremities A' and B' communicate with the two plates of a condenser, A' will give it a charge of positive electricity, and B' one of negative. As soon as *a'* has lost its positive electricity and *h'* its negative, the negative of *a'* is then disguised by the positive of *b'*, and so on to the negative of *g'*, which is disguised by the positive of *h'*; these electricities do not neutralize each other, because they are retained by the opposite electricities of the particles of A B; but if at the instant that the current ceases to pass in A B, the two extremities of A′B′ are united by a conductor, the negative electricity of *a′* unites with the positive of *h′*, and at the same time the contrary electricities of each of the particles of *a′*, *b′*, *c′*, *d′*, *e′*, *f′*, *g′* combine, and thence there results a current which progresses in the conductor from B′ to A′ and from A′ B′ in the wire A′B′ itself. Thus A′B′ is traversed, in this case, by a current directed in the same direction as the inducing current. The state of electric tension which exists in the wire A′ B′ whilst the current traverses A B is that which Faraday has called *electro-tonic;* and the cessation of that state produces the second current of induction, while its creation produces the first. * * * * In reality in the above theory which we have given, the production of the two instantaneous induced currents is altogether similar to that which passes in the charging and discharging by cascade of several consecutive Leyden jars, in which the inner coating of each communicates with the outer coating of the preceding one." De la Rive then shows how this hypothesis is applicable to the explanation of the production of induced currents, by the approach and recession of a current in reference to a closed circuit; to the production of induced currents by magneto-electric currents; and to all the facts embodied in Lenz's laws.

It appears to me that the truth of the above hypothesis can be tested in the following manner. A closed metallic circuit (which we will call the secondary wire), is in proximity to a wire carrying a voltaic current, (which we will call the primary wire), which produces in the former powerful induced currents, on making and breaking battery contacts. While in these circumstances, we pass through the secondary wire a direct current, and measure with precision its intensity; then an *exactly equal* current is passed in an inverse direction, and its intensity measured. Now, if as De la Rive supposes, the secondary wire be in a state of polarization like in character but inverse in direction to that produced in the primary by the passage of the current, there will be a diminution in the intensity of the current which traverses the secondary wire in a direction opposed to this polarization, while that traversing it in the direction corresponding to this polarization, will have the same intensity as when it traverses the secondary wire, when the primary current is not in its proximity.

Four conditions have to be fulfilled in the above experiments. First, a strong inductive action must be brought to bear upon the secondary wire; 2dly, this action must be produced by a constant current; 3dly, the secondary wire must be a good conductor, and therefore cannot have in its circuit a liquid battery, wherewith to propagate the current in this wire; 4thly, a means must be devised of producing at will, in the secondary wire, a current or wave of electricity which shall always have the same intensity. The following apparatus combines these requirements in an eminent degree. Twenty-five spirals (such as are described in my papers in the Sept. and Nov., 1870, Nos. of this Journal) were placed between twenty-five similar spirals, so that each alternate spiral belonged to the same circuit. The terminals of the first series of spirals were connected with a galvanic battery, while those of the second combination were connected with a spiral similar to one of those described in the paper "on the measurement of electrical conductivities," in the Nov., 1870, No. of this Journal. This spiral was placed on a magnet, about 3 ins. distant from its end, so that by suddenly slipping it off a current could be produced in the secondary wire without the interposition of a liquid. By interchanging the connections of the terminals of this spiral, an inverse current could be produced on sliding it off. A reflecting-galvanometer, reading deflections to 15″, was also placed in the above circuit.

If the spiral is always removed from the same length of magnet with the same velocity, it necessarily follows—the circumstances in each case being alike—that successive currents of equal intensity will traverse the secondary wire. This constancy of velocity in all the experiments can be produced in the following manner. The magnet was placed vertically, N. pole downward, and the terminals of the spiral, which were 18 ins. in length, were connected with the ends of a cylinder of copper, transversely divided by an insulating disc of ebonite. Each end of this horizontal cylinder rested on a V, and a close contact was ensured by amalgamation. The spiral was now allowed to fall off the magnet, and as it always made this movement with the same velocity, it followed that currents of equal intensity were produced during each fall. It was however found that currents of such equality of intensity were produced, by *quickly* slipping off the spiral, that the range of their differences did not exceed 20″ in the deflection of the needle of the reflecting-galvanometer. In the experiments which follow, I used the currents produced by quickly removing the spiral from the magnet. This ready method of producing at will an electric current or wave of any required intensity, seems to me will be of value in many electrical researches, for I have found that any current, produced by chemical means, fails in constancy when its intensities are measured by a reflecting-galvanometer, though by the ordinary instrument it may appear so.

In the apparatus thus arranged we have a combination of 25 spirals, containing 367 feet of $\frac{1}{20}$ inch copper wire, in proximity to a combination of 25 similar spirals. A current was passed through the first spirals, of such a strength that the resistance in the battery equalled the outside resistances in the spirals, &c.

After the violent action at the galvanometer produced on making contact at the battery had subsided, and the needle was at rest, its position was determined. The spiral on the magnet was now slipped off, and the deflection of the needle precisely observed. The battery current was now broken; the connections of the terminals of the spiral interchanged, and contact at the battery formed. The spiral was now again removed from the magnet, and the deflection measured. It was found that the deflections of the needle in the first and second experiments gave (for the mean of 6 experiments of each) angles sensibly equal, and that with a galvanometer reading with precision, a deflection to 15″, and whose needle made about three vibrations per minute. These experiments were many times repeated with the current of the battery reversed in the primary spirals as well as in the magneto-current in the secondary spirals, and always with the same results.

Therefore this fact (irrespective of any theoretical consideration) is established:—*that a definite electric current, traversing a metallic circuit in proximity to another traversed by a powerful voltaic current, has the same intensity whether passed in the same direction as the latter or in a direction opposed to it.* There is, however, no doubt, a diminution in the *velocity* of this current similar to that observed in submarine cables; and it will be interesting and important to ascertain whether that velocity is the same in a direct as in an inverse direction. At another time I propose solving this question, and it would be well to reserve until then any hypothesis as to the real condition of a closed circuit contiguous to another carrying a voltaic current. It has always, however, appeared to me that the explanation of dynamic induction given by Prof. W. A. Norton (in this Jour., Jan., 1866,) in his paper on "Molecular Physics" affords a simpler and more consistent explanation of these phenomena than any heretofore framed.

Faraday (Exp. Res. 20 and 33) has also attacked the problem discussed in this paper. He introduced a small voltaic arrangement in the circuit of the secondary wire so as to produce a deflection of 30° or 40° in the galvanometer needles, and then a powerful battery was connected with the primary wire. He found, that after the deflection produced by the induced current had subsided, the needle resumed its former position and such he found was the case whichever way the contacts were made. For the following reasons I do not consider these experiments sufficiently refined to have solved so delicate a problem. First, from many experiments, which I have made, I have shown that no voltaic combination, however constant in the usual acceptation, can be formed so as to hold a galvanometer-needle even approximately in one position for only a minute, when it is examined by the method of reflection. Secondly, a needle already deflected 30° or 40° has lost its delicacy in showing any minute increase or diminution in the intensity of the current; thirdly, the greatest objection to this method is this very feeble induced current that can be sent through the great resistance of the battery in the circuit of the secondary wire; finally, the manner of reading the galvanometer indications is entirely too gross.

Faraday also (Exp. Res. 3186) approximately showed that when a magnet is quickly introduced into a wire loop or quickly withdrawn from the same that the currents induced in the latter, as measured by an ordinary galvanometer, are of the same intensity; but a deflection on such an instrument cannot be read closer than 15′, while in my experiments I have shown with more refined apparatus that magneto-electric waves can be evolved not differing more than 20″ in the deflections which they produce.

Though ignorance of science excuses one no more than ignorance of the law, yet I may remark that this apparatus was devised and the results obtained before I was aware of Faraday's work in the same direction.

Those who would use this means of obtaining magneto-electric waves of equal intensity must guard against changes of temperature; for both the intensity of the inducing magnet and of the galvanometer needles vary with the temperature, while the resistance of the wire of the spiral and of the galvanometer rises and falls with the same. Indeed if a method could be devised of keeping the wires and the galvanometer needles at a constant temperature while we altered that of the inducing magnet a refined method would present itself for the determination of the variation of the force of magnets with the temperature. Probably the effect of the heat upon the wire circuit could be tabulated and eliminated from the results of such experiments, thus leaving a residual which will express the effect of temperature on the magnet. Or, a differential apparatus might be devised, consisting of two magnets with two wire circuits passing through a differential galvanometer. Having brought the induced currents of the two magnets to equal actions by an interposed resistance, we could then, by altering the temperature of one of the magnets, ascertain its effect with great precision; and it could be expressed in the length of resistance required again to balance the disturbed equality of the magnets.

November 7, 1870.

## ART. V.—*Abstract of the Programme for the Observation of Stars to the Ninth Magnitude, undertaken by the German Astronomical Society.**

THE Astronomical Society undertakes the construction of a complete catalogue for the northern heavens of the stars of the first nine magnitudes, upon the basis of the Bonn Durchmusterung. The region to be observed lies between −2° and +80° of declination. The region around the pole is not included, as the labors of Carrington, the Kasan and the Hamburg observatories render a repetition of this work superfluous on the part of the Society. The work will be distributed as follows: Kasan 80° to 75°; Dorpat 75° to 70°; Christiania 70° to 65°; Helsingfors 65° to 55°; Cambridge, U. S., 55° to 50°; Bonn 50° to 40°; Chicago 40° to 35°; Leipzig 35° to 30°; Cambridge, Eng., 30° to 25°; Berlin 25° to 15°; Leipzig 15° to 10°; Mannheim 10° to 4°; Neuchâtel 4° to 1°; Palermo + 1° to −2°.

The limits of these zones refer to the equinox of 1855·0, which is that of the Durchmusterung. For purposes of comparison, the limits above given will be exceeded 5′ to 10′, and in very northerly regions even more.

In particular the stars to be observed are as follows: All stars of the D. M. within the prescribed limits having a magnitude of 9·0 or brighter; all stars fainter, which also occur in the Histoire Celeste (marked in the D. M., L), or in the Königsberg zones (marked K), or in the Bonn zones (marked A); a part of these latter, which have been recently determined at Bonn, (marked B). A comparison of the older collections of observations is consequently necessary for completeness.

Every star will be observed twice. Whenever necessary to discover disagreements, a third observation should be made. The observations will be differential in their character, and will depend upon a catalogue of 539 zero stars, to be determined at Pulkova.

To facilitate reduction as well as observation, it is recommended to the observers to divide the zones into subzones. It is deemed inexpedient to observe zones of a length of more than one hour and a half, both on account of the physical fatigue and also the too wide separation of the fixed points of reference. Two zones of one and a half hours each are preferable to a single zone of three hours.

The clock error and pole point will be determined altogether by means of stars from the Pulkova catalogue, mentioned above. At least two zero stars must immediately precede and follow each zone. Whenever desirable or necessary, however, one or more may be observed during the progress of the zone. In the selection of zero stars the peculiarities of the instrument must govern. In general the mean of their right ascensions should fall nearly on the mean of the zone. Where this cannot be attained, the observer must decide whether he can rely more upon a uniform clock rate (for the determination of right ascensions), than upon an unchanged position of the instrument in reference to the meridian. With very northerly stars the selection should be made more with regard to the declinations of the zero stars, as an error in the clock rate has less influence here. The mean daily clock rate must not be used in the reductions, but the rate resulting from the mutual comparison of the zero stars for the zone.

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* **Prepared for this Journal by A. N. SKINNER, of the Naval Observatory, Washington.**

The individual observer must judge whether a single microscope will give the requisite security in declination. Whenever the stars to be determined are observed on fewer microscopes than the zero stars, a thorough investigation of the reduction between the different systems of microscopes must be made throughout each zone. Where this reduction shows large changes, the use of all four microscopes is advised, and also the introduction of zero stars in the progress of the zone. Changes in the equatorial point may be determined also by horizontal collimators.

Where two share in the work, so that one reads the microscopes, and especially where only one microscope is read, the influence of the warmth of the observer's body must be carefully investigated and allowed for. (Consult Bonn Beob., II, p. viii).

In the observation of double stars the position of the mean is to be obtained. It is therefore advisable to extract from the Positiones Mediæ the double stars occurring in a zone. Should a star designated there as "simplex" appear double, in case of nearly equal brightness, the mean should be observed as well as the brighter one.

An ephemeris of variable stars will be published annually in the Vierteljahrschrift, to furnish information in regard to the most favorable times of observing them on the meridian.

There are many stars of the $9{\cdot}0^m$ in the D. M. which are fainter, and it is much oftener so with those marked A. The observer is enjoined to spare no pains in observing these stars, and should the observation not succeed in the course of the zone, note should be made so that it may be attempted under more favorable circumstances. Where variability may be suspected because a star is invisible or excessively faint, it is advisable to immediately inform the committee or those astronomers engaged on variable stars, that these stars may be carefully attended to. A notice to the Bonn observatory would render it possible to scrutinize the original papers for any error.

Unless special circumstances prevent, the magnitude is to be carefully estimated at the observation of every star. It is desirable that the participants conform their scale of magnitudes to that of the D. M., unless some other scale is already in use; in that case its relation to the D. M. scale must be determined. (Consult Bonn Beob., III, p. xviii, ff.) To guard against a difference between observations of bright and faint stars, observers are recommended to observe variable stars in different stages of their brightness.

The choice of wire intervals both vertical and horizontal requires mature deliberation. The former must be arranged according to the declination; rather wide for equatorial zones, and rather narrow for northern zones. For eye and ear observing, wire intervals of $10^s$ to $12^s$ are recommended. Equidistant wires and in zones near the equator intervals of a whole number of seconds are to be avoided. With the chronographic method intervals of $2^s.5$ to $3^s$ will suffice. The choice of narrower intervals cannot be recommended. The horizontal wires should not be too close, because the fainter stars cannot be seen distinctly through them. A definite precept cannot be given, as the magnifying power employed is closely connected with the question. The observer will do well to ascertain what distance suits him best. Bessel used at first a power of 66 times and afterwards one of 107 times; a third of 119 times, which was perhaps more proper, was not employed on account of its small field of view, a difficulty not to be encountered in the present work, as each star can be directly set upon. The distance of the horizontal wires was 8″, which is probably rather narrow. The Bonn northern zones were observed with a power of 108 times, those published in vol. vi with one of 150 times. The horizontal wire interval at Bonn is 14″, which is perhaps too wide; 10″ to 12″ may perhaps be more advantageous.

The final catalogue will be reduced to the equinox of 1875·0. It is earnestly recommended to make the reduction of the observations as soon as possible, so as not to be pressed at a later period by the work. Of course a definitive reduction is possible only when the accurate determinations of the zero stars are completed at Pulkova, which will take several years. Meanwhile the provisional places given at present will be so nearly correct that only small corrections will need to be introduced. This reduction will afford an opportunity of judging what security of position is arrived at and where perhaps a third observation is to be added. It will, it is hoped, appear from all the observations that the mean difference between two observations of the same star will not exceed $0^s.1$ in R. A. (for northerly stars proportionally more), and 1″·2 in declination. This indeed is completely sufficient. It would follow from this that the probable error of a mean of two observations is 0$^s$·04 and 0″·05. But with the above mentioned mean differences among 22 chances the differences 0$^s$·25 and 3″ would occur once, and among 142 chances those of 0$^s$·34 and 4″·1 once. Accordingly it would be advisable perhaps as often as differences occur which exceed 0$^s$·3 and 3″·5 to make a third observation for verification.

The observer will do well to inform himself completely on the subject of the introduction of the D. M., found in Bonn Beob., III. It is there noticed that sometimes two very close faint stars by their united light have given cause to the introduction of a 9$^m$ star which does not exist; such are to be observed if bright enough. If a 9$^m$ star should be found which is not in the D M., and these cases are very rare, it is to be observed and the fact carefully noted, to be published in the final catalogue.

To secure the internal connection and completion of the whole, the participants are urgently requested to transmit, before July of each year, annual reports on the work of the year to the President, or one of the Secretaries, of the Society.

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## ART. VI.—*On Gahnite from Mine Hill, Franklin Furnace, New Jersey;* by GEO. J. BRUSH.

THE rare species Gahnite has been again found at a new locality in a cross-cut made by the New Jersey Zinc Co. from the valley of the Wallkill river to an opening on the south end of Mine Hill. I collected specimens at this locality in the summer of 1869, and by blowpipe examination at that time determined the mineral to be a zinc spinel.

The mineral differs in its crystalline characters from the specimens of other localities in the frequent occurrence of the cubic plane; in fact the cubic planes are often the largest, so that the crystals are cubes with truncated dodecahedral edges and only small octahedral planes. There are also minute planes of the trapezohedron 2-2, truncating the edges of the dodecahedron; also others of the trigonal-trisoctahedron 3. Besides these there are sometimes two planes between the cubic and the octahedral, which appear, from examination and approximate measurements by Prof. Dana, to belong to the forms 4-4 and 8-8. Their surfaces are rounded, and feeble in luster, and generally they are blended in a single curved plane, consequently the measurements are not entirely satisfactory. The inclinations on a cubic plane, obtained by Prof. Dana, are for 4-4, 160° 30′, for 8-8, 170° 30′.

The crystals vary in diameter from an eighth of an inch to over an inch and a half; generally, however, they are less than half an inch. The color of the crystals is blackish-green; in thin fragments, olive-green. Hardness = 7·5. Specific gravity =4·89—4·91.

Before the blowpipe the mineral is infusible. With the fluxes reacts for iron and manganese; and with soda on charcoal gives a zinc coating.

The analysis in the wet way was made by Mr. Joseph S. Adam of this laboratory. The mineral was decomposed by fusion with bisulphate of potash. The silica was separated in the usual manner, and the iron and alumina thrown down as basic acetates, and this precipitate was examined to insure purity. The iron was determined by titration with permanganate of potash. From the acetic solution the manganese was separated by bromine, and the zinc was thrown down from the filtrate by sulphid of ammonium. The small amount of magnesia was determined as pyrophosphate, care having been first taken to separate the minute traces of it which were found precipitated with the alumina.

Two analyses by J. S. Adam gave:—

| | I. | II. | Mean. | | |
|---|---|---|---|---|---|
| Alumina, | 49·86 | 49·70 | 49·78 | 23·20 | 25·77 |
| Ferric oxyd, | 8·83 | 8·33 | 8·58 | 2·57 | |
| Zinc oxyd, | 39·39 | 39·84 | 39·62 | 7.82 | 8·12 |
| Manganous oxyd, | 1·20 | 1·07 | 1·13 | ·25 | |
| Magnesia, | 0·12 | 0·14 | 0·13 | ·05 | |
| Silica, | 0·71 | 0·42 | ·57 | | |
| | 100·11 | 99·50 | 99·81 | | |

This gives the relation of the oxygen of $\dot{R}$ and $\bar{R}$ as 8·12 : 25·77, or 1 : 3·17, which would indicate that a small portion of the iron was present as protoxyd. We have but to assume 1·56 per cent of the $\bar{Fe}$ in the analysis to have existed as $\dot{Fe}$ in the mineral to reduce the ratio to exactly 1 : 3.

This variety of gahnite shows a larger percentage of zinc than any heretofore analyzed, and is unique in its cubic habit. It is associated with black mica, apatite, calcite and a brownish variety of chrysolite. A partial analysis of this chrysolite by W. G. Mixter shows it to be a unisilicate of iron, manganese, magnesia and zinc, probably related to, and possible identical with, the zinciferous chrysolite described by Prof. W. T. Rœpper, in this Journal, II, 1, 35. A tin-white metallic mineral imbedded in some of the gahnite crystals proved to have the pyrognostic characters of leucopyrite.

Sheffield Laboratory of Yale College, Nov. 1870.

## ART. VII.—*Meteors of November 13th–14th, 1870.*

1. *At New Haven.*—On the morning of the 13th of November, 1870, Mr. Charles S. Hastings and Mr. W. B. Roberts, of the Sheffield Scientific School, and Mr. A. A. Murch, of the Academical department of Yale College, watched for meteors upon the tower of Graduates' Hall, in New Haven, from half-past twelve to half-past three A. M. The sky was clear, or nearly so. The following is the result of the count:—

| | | | | | |
|---|---|---|---|---|---|
| From | $12^h\ 30^m$ | to | $1^h\ 0^m$ | 2 unconf. | 1 conf. meteors. |
| | 1 0 | | 1 30 | 4 | 2 |
| | 1 30 | | 2 0 | 6 | 1 |
| | 2 0 | | 2 30 | 7 | 1 |
| | 2 30 | | 3 3 | 3 | 1 |
| | 3 0 | | 3 30 | 3 | 0 |
| | | In 3 hours, | | 25 unconf. | 6 conf. meteors. |

The moon was about one sign in advance of the radiant, and evidently diminished very much the number of meteors that could be seen. Probably two-thirds or three-fourths of the whole number were thus made invisible.

On the next morning, that of the 14th, the writer, with Messrs. O. Harger, E. S. Dana, C. B. Dudley, J. McNaughton and R. P. Maynard, watched from shortly after eleven P. M. of the 13th, onward, with the following result:—

| Time.<br>h. m. h. m. | Unconf. met. | Conf. met. | No. of obs. | State of sky. |
|---|---|---|---|---|
| 11 5 to 11 30 | 6 | 0 | 3½ | Clear. |
| 11 30 " 12 0 | 8 | 1 | 4 | " |
| 12 0 " 12 30 | 4 | 5 | 6 | " |
| 12 30 " 12 45 | 3 | 5 | 6 | " |
| 12 45 " 1 0 | 4 | 5 | 6 | " |
| 1 0 " 1 15 | 5 | 3 | 6 | " |
| 1 15 " 1 30 | 3 | 9 | 6 | " |
| 1 30 " 1 45 | 4 | 8 | 6 | " |
| 1 45 " 2 0 | 6 | 1 | 6 | " |
| 2 0 " 2 15 | 5 | 7 | 6 | " |
| 2 15 " 2 30 | 10 | 8 | 6 | Light clouds. |
| 2 30 " 2 45 | 5 | 6 | 6 | Fleecy clouds over all the sky. |
| 2 45 " 3 0 | 2 | 2 | 4 | Cloudy. |
| 3 0 " 3 15 | 3 | 7 | 6 | Some clouds. |
| 3 15 " 3 30 | 4 | 5 | 6 | " |
| 3 30 " 3 45 | 2 | 7 | 6 | More cloudy. |
| Total in 4h 40m, | 74 unconf. | 79 conf. | | |

From $3^h\ 45^m$ onward the sky was so nearly overcast that regular counting was abandoned. Here and there open spaces in the clouds enabled us to be assured that up to six o'clock there was not a marked increase in the number of meteors. After half-past five, however, the clouds more nearly covered the sky.

As on the preceding morning, the moonlight was very bright. In the earlier part of the watch there was an aurora, with streamers reaching up half or two-thirds of the way to Polaris.

We called those meteors conformable which moved in paths which if produced backward would cut the curve of the sickle in Leo. But in the practical application of this criterion to tracks distant from the radiant it is probable that any which would strike within 10° of the center of the sickle were called conformable.

Of the apparently conformable meteors, some were undoubtedly accidentally so. The earth's motion being so nearly toward the radiant, a special tendency toward conformability in the sporadic meteors was the result. If we take 15 per cent of the 74 unconformable meteors away from the 79 conformable ones, and add it to the 74, it would be, I think, a tolerable correction for the *accidental* conformability. The numbers would then stand 85 unconformable meteors, and 68 November meteors, or *Leonids* as they have been called.

The only meteor seen by me near the sickle would correspond to a radiant one-third or one-fourth of the way from *gamma* to *epsilon* Leonis. It was moving at a large angle with the line joining those stars.

Many of the conformable meteors had the peculiar light and train which belong to the Leonids.

On the morning of the 15th the sky was overcast at New Haven. Between eleven and twelve o'clock P. M. of the 14th, however, there were a few breaks in the clouds. I think there could not have been any great number of meteors at that time, as I did not see a single one through the openings.

2. *At Brunswick, Me.*—The following is from a letter of Prof. Rockwood of Bowdoin College.

"I was abroad from $0^h 45^m$ till nearly $5^h$ A. M., Nov. 14th, and assisted by two members of the senior class of Bowdoin College, kept a watch and count as given below. The time is local time, as nearly as could be ascertained.

| Time. | Conformable. | Unconformable. | Total. |
|---|---|---|---|
| $1^h 20^m$ to $2^h$ | 4 | 4 | 8 |
| $2^h 15^m$ " $2^h 45^m$ | 20 | 4 | 24 |
| $2^h 58^m$ " $3^h 30^m$ | 25 | 4 | 29 |
| $3^h 40^m$ " $4^h 10^m$ | 17 | 4 | 21 |
| | 66 | 16 | 82 |

"We saw 10 or 12 more, mostly conformable, at times when not engaged in the formal count. The sky was mostly clear, but sometimes partly obscured by a few light passing clouds.

"The number of meteors was not large but sufficient to prove the return of the November shower. Especially noticeable facts were—(1) the almost perfect conformity to the radiant of brighter meteors; (2) the uniformity in the number of the unconformable meteors.

"On the morning of Nov. 15th, 1870, it was cloudy and raining."

Upon the chart sent by Prof. Rockwood are six tracks of meteors observed by himself. The following are their apparent places of beginning and ending.

| Time. Nov. 14th. | Beginning. R. A. | Beginning. Dec. | Ending. R. A. | Ending. Dec. |
|---|---|---|---|---|
| $2^h\ 49^m\ 30^s$ | 142° | +40¼° | 135° | +51° |
| 3 25 10 | 134 | +13½ | 126¾ | + 8 |
| 3 40 30 | 139 | +30½ | 133½ | +35½ |
| 3 42 30 | 145 | +20¼ | 141¾ | +18¼ |
| 4 4 20 | 141½ | 0 | 136¾ | −10½ |
| 4 9 30 | 150⅛ | − 2¼ | 150½ | −14½ |

The fourth of these paths was close to the radiant and would, if carried back, cut the line joining $\gamma$ and $\varepsilon$ Leonis *three-sevenths* of the way from *gamma*.

3. *At Burlington, New Jersey*, November 14, 1870.—Mr. B. V. Marsh observed meteors as follows: from $0^h\ 30^m$ A. M. to $0^h\ 45^m$ A. M., looking south from a window, 3 conformable. In the open air, attention directed principally toward the south, sky *perfectly* clear:

| | A. M. | | A. M. | Conformable. | Non-conform. | Total. |
|---|---|---|---|---|---|---|
| From | $1^h\ 30^m$ | to | $2^h\ 0^m$ | 4 | 1 | 5 |
| | 2 0 | " | 2 30 | 3 | 0 | 3 |
| | 2 30 | " | 3 0 | 4 | 1 | 5 |
| | | | | 11 | 2 | 13 |

Towards 3 o'clock clouds began to interfere materially, and at daylight the whole sky was covered. About half the number were equal to stars of 1st magnitude and several had trains, but there was no one that was worthy of special remark.

Mr. John G. Gummere from 1½ to 3 o'clock, saw 9 conformable and 2 non-conformable; total 11.

Prof. Kirkwood reports a cloudy sky at Burlington, Ind.

Probably Prof. Rockwood and Mr. Marsh had a less sharply marked criterion of conformability than that employed by us in New Haven. As the result of all our numbers, we may say that the number of Leonids visible on the morning of the 14th of November, was probably about equal to, perhaps exceeding, that of the sporadic meteors. In view of the disturbing effect of moonlight this comparison is more valuable than any comparison with the absolute numbers counted in clear nights.

H. A. N.

## ART. VIII.—*On some phenomena of Binocular Vision;* by JOSEPH LECONTE, Prof. Geol. and Nat. Hist., Univ. of California.*

### IV. *The mode of representing the position of double images.*

IT is well known that if two objects, as a finger of each hand, be placed one beyond the other in the median line of sight, when the eyes are fixed upon the nearer object the farther object is seen double, the images being *homonymous*, i. e. on the same side as the eyes to which they belong: and when the eyes are fixed upon the farther object the nearer object is seen doubled, the images being in this case *heteronymous*, i. e. opposite the eyes to which they belong. These familiar facts are usually represented graphically as follows: Let R and L, figs. 1 and 2, represent the right and left eye, and A and B the two objects. Now when the eyes are directed upon A, fig. 1, then the light from B will impress the *temporal* halves of both retinæ and B will be seen by the right eye at *b* and by the left eye at *b'* (heteronymous); but if the eyes be directed upon B fig. 2, A will impress the nasal sides of the two retinæ, and be seen as homonymous images at *a* and *a'*. (In all cases in this paper objects seen single are represented by capitals, right eye images by plain italics, and left eye images by dashed italics). It will be observed that in both cases the doubled images are referred to a plane passing through the point of sight at right angles to the visual plane. For convenience I will call this the *plane of sight*. Now every one who has ever tried the experiment knows that the double images are not thus referred in natural vision, but on the contrary are seen at their real distance, though not in their real position. The figures therefore though they truly represent the parallactic position of the double images do not represent truly their apparent distance. If on the other hand we attempt in our figures to refer the images to their proper distances, observing the law of direction, then they unite and form one; which is equally incorrect. It is evident therefore that these figures cannot represent truly the visual results.

The falseness of this mode of representation becomes much more conspicuous, if instead of two points or small objects, we substitute a line or rod. In this case the absurdity of projecting the images on the plane of sight is so evident that it is never attempted. The universal mode of representing the visual result of a rod placed in the median line of sight is shown in the accompanying figures. Fig. 3 represents the actual position of the rod AB in the median line of sight, fig. 4, the visual result when the eyes are directed upon A, and fig. 5 the visual result when the eyes are directed upon B. Now it will be observed that in both these figures the image of each eye is coincident with the visual line of the opposite eye, and therefore makes an angle with its own visual line equal to the visual angle. But this is not true. Fig. 3 shows that it ought to make but half that angle. If these figures therefore represent truly the position of the images, as indeed they do, then they do not represent truly the visual or apparent positions of the visual lines. The truth is, in natural vision the visual lines are shifted as well as the images of all objects not situated at the point of sight, and to the same degree, so that their positions relative to the visual line are perfectly maintained in the visual result.

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* For the preceding articles on this subject, see II, xlviii, 68, 153.

Figures constructed on the usual plan give correctly the position and distance of objects seen single, but fail to represent truly the place of double images. They are well adapted to express binocular combinations of similar objects or similar figures on the plane of sight, as in my previous experiments; and to some extent also in the stereoscope, but are unadapted to express the results of binocular vision of natural objects.

I propose therefore a new, and I am convinced, far truer mode of representing the results of binocular vision, applicable to all cases. I am satisfied that if this mode had always been used much confusion would have been avoided. Some preliminary explanation will be required to make the method clear.

If a *single* object, as a finger, be placed before the eyes in the median line of sight and the eyes be directed to a distant point, the object will be seen double, the heteronymous images being separated by a space exactly equal to the interocular space. Now, the *nose* is no exception to this law; the nose is always seen double and bounding the *common field* of view on either side. Again if *two similar* objects or figures be placed before the eyes in the plane of sight and separated by a space equal to the interocular distance, and the eyes be directed as before to a distant point, both objects will be doubled, but two of the doubled images, viz: the right eye image of the right object and the left eye image of the left object, will combine to form a *single binocular image* in the middle, while the right eye image of the left object will be seen to the left and the left eye image of the right object will be seen to the right. Thus there will be three images seen; the middle one binocular, the right one belonging to the left eye alone and the left one belonging to the right eye alone. Now, *the eyes themselves are no exception to this law.* In binocular vision the eyes themselves seem to double; two of them combining to form a *binocular eye in the middle* which looks out between the two noses, while the other two are on either side beyond the noses. Each eye seems *to itself* to occupy the central position while it sees (or would see if the nose was not in the way) its fellow on the other side of the nose. In other words, in binocular vision when the eyes are fixed upon a distant object the whole field of view, including the parts of the face, is shifted by the right eye one half the interocular space to the left, and by the left eye the same distance to the right, without altering the relative position of parts. By this shifting it is evident that the two eyes with their visual lines are brought in perfect coincidence, so that *identical points* in the two eyes are perfectly united.

The outline of the field of view varies somewhat with the prominence of the nose, brows and cheek bones, but its general form is much the same in all persons. I give in the accompanying figure (fig. 6) a rude outline of the field of view in my own case, *n n r r* being the field of the right eye, and *n′n′ ll* the field of the left eye, and the irregular space *nn n′n′* being the common field of binocular vision bounded by the outline of the nose *nn* as seen by the right eye, and *n′n′* as seen by the left eye. The circle E represents the position of the combined eyes in the center of the common field, *l* and *r′* the position of the two eyes as seen each by the other or rather as they *seem* each to the other. A vertical projection is shown in fig. 7. E being the combined eyes, *n* and *n′* the nose as seen by the right and left eyes respectively on either side of the common field, and *l r′* each eye as seen by the other. It will be observed that I have represented the eye on the extreme *right* by *r′* instead of *r*, and on the extreme *left* by *l* instead of *l′*. The reason is that these, like the two noses, are only heteronymous *images* seen by the two eyes respectively from their central position. As an *organ* of vision the two eyes occupy the central position only, but as an *object* each from this central position sees its fellow on the other side of the nose right and left. This vertical projection I shall use in all my diagrams representing double images. By its use, however, we may represent equally well the position of objects or images seen *single* at the point of sight. By this method the visual results of even the most complicated figures, not only may be represented truly and with ease, but may be *worked out* a priori with the utmost certainty. The great importance of this a priori help will be appreciated by all who have made experiments in binocular vision, and who therefore know how easy it is to overlook, or rather how difficult it is often to perceive, many of our visual impressions.

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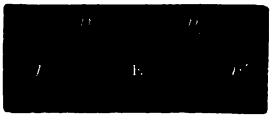
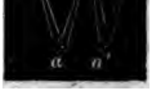


As we have already stated, while we gaze at a distant horizon any object in the median line *whatever be its distance* is seen double, the space between the images being exactly equal to the interocular space. Evidently then the median line of sight itself is doubled and becomes two lines which, resting upon the nose on each side of the common field of view, run out parallel to each other. *Between these two lines* the combined eyes look out along the *combined visual lines*, at the distant object. If the position of the median line of sight be occupied by a *real* line or rod we shall *see* two parallel lines or rods; if it be occupied by a *plane* as in the stereoscope, we shall see two parallel planes bounding the view on either side, between which we look.

Suppose now we take a slender rod AB *n* (fig. 8) like a straight wire, and placing one end on the root of the nose and the finger on the farther end, so that it occupies the position of the median line of sight, we look at a distant horizon. As already stated we shall see two parallel rods between which we look at the distant point, (fig. 9). If now we look at a nearer point the rods will converge, carrying all objects in the fields of view with them, and meet at the point of sight. If for example we look at the finger A, the rods will form a triangle of which the finger is the point and the distance between the two noses the base (fig. 10); if we look at a still nearer point B, the rods, still turning upon the noses as a fixed point, will cross each other at the point of sight, (fig. 11). At the same time the two eyes with their visual lines combine to form a median eye and a *true median line of sight* (the dotted line in the figures), passing through the point of sight and beyond to infinite distance, and this line might well be called by this name if the name had not been already appropriated for another line.

It will be observed that in the above paragraph I have used very much the same language as other writers on this subject, and used a similar mode of representation; only that I have substituted the eyes in the place of the nose and put noses in the position of the eyes. I have made median lines cross each other at the point of sight instead of visual lines, and visual lines combine in the middle as a true visual median line. In other words, I have used the true language of binocular *vision.*—I have expressed what we *see* rather than what we *know*, the language of simple appearance rather than that mixture of appearance and reality which form the usual language of writers on this subject.

In all the experiments which follow it will be necessary to get the interocular distance with accuracy. This may be very conveniently done by taking an ordinary pair of dividers, holding it up at arms length against the sky or a cloud, and while gazing steadily at the sky or cloud, opening the points until the double images of the points shall two of them coincide perfectly, thus: The distance between the points $bc$ (equal to $aa'$) is the interocular distance.



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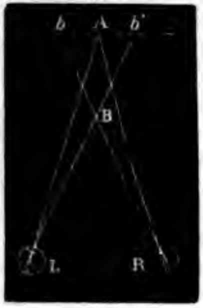

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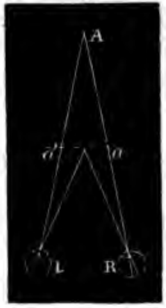

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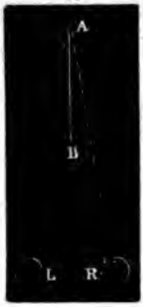

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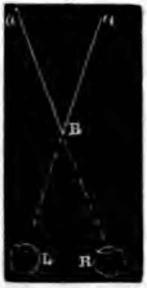

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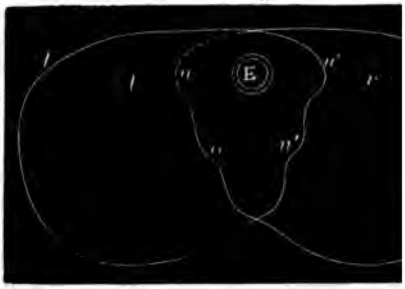

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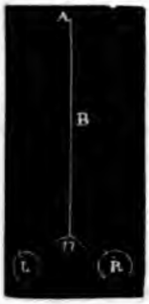

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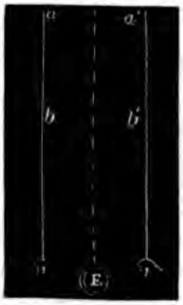

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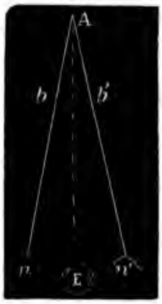

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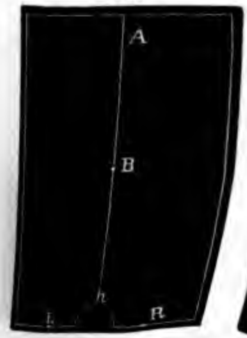

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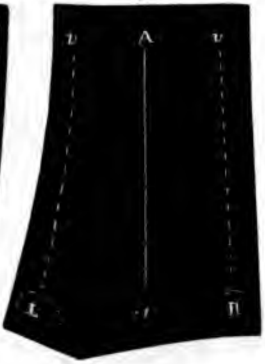

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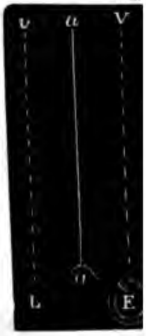

I will now give a few very simple experiments and the visual results, represented in the manner already indicated. Let a smooth white plane about twenty inches long and of any convenient width, be prepared by pasting white paper on a smooth flat board, (fig. 12). Mark two points. R and S with a space between them exactly equal to the interocular space. In the middle between the two points notch the end of the board so as to fit over the bridge of the nose. From the notch *n* draw the line *n*A in the position of the median line of sight when the notch is fitted on the nose,. and on this line place pins at A and B. If now, the plane be fitted on the nose and held in a horizontal position a little *below* the visual plane, so that both the pins and the line can be distinctly seen, and the eyes be directed upon a distant object; then, as already stated the median line will be seen as two parallel lines separated by a space equal to the interocular space. If in addition to the median line the position of the visual lines be represented by dotted lines, then fig. 13 will represent the *actual* relation of parts, and fig. 14 the *visual* result. It will be observed by comparing the visual result with the drawing, that the parts of the face, the whole plane and all the objects and lines on the plane are shifted by the right eye one half the interocular distance to the left, and by the left eye the same distance to the right; the two visual lines of the drawing are combined in the result to form a true median binocular visual line EV, while the median line of the drawing is doubled, forming heteronymous images, which in the result occupy the position of the visual lines of the drawing. Besides these three lines, there are seen two other dotted lines *lv* and *r′v′*. These are not visual lines proper, i. e. lines along which vision takes place, but they are the visible representatives of the visual lines of each eye seen *as objects* by the other eye.

Next, having removed the dotted lines in the previous experiment, let the eyes be directed upon the pin A, and dotted lines be again drawn in the direction of the visual lines as in fig. 15. The visual result is shown in fig. 16. By comparing this visual result with the actual drawing it will be seen that the whole triangle L A R, is turned upon A as a fixed point a half interocular distance to the left by the right eye, and to the right by the left eye.

Next, having again erased the dotted lines of the previous experiment, and substituted dotted lines crossing at B as in fig 17; let the plane be again adjusted to the nose and the eyes directed upon the pin B. The visual result is shown in fig. 18. In this visual result the whole drawing (fig. 17) is apparently rotated about the point of sight B in opposite directions by the two eyes, through a distance represented by the angle *n*BR or *n*BL = half the visual angle. As objects on the nearer and the farther side of the point B must move in opposite directions, the double images beyond B must be homonymous. In this experiment (as also in a less degree in the last), since the eyes are converged, the distance between the points L and R *on the plane*, must be a little less than the interocular distance.

In both the above cases the visual result is the drawing rotated about the point of sight in opposite directions through one-half the visual angle; and for convenience I have spoken of the eyes as accomplishing this rotation. But this is not strictly true. The fields of view of both eyes are *habitually* and *normally* shifted one-half interocular space right and left heteronymously, when the eye is in a *passive* state. Under these conditions the visual results of figs. 15 and 17 would be figs. 19 and 20. But in converging the eyes upon A or upon B, the median lines *n b a*, *n'b'a'* turning upon *n* and *n'* as fixed points approach each other, meet and cross at the point of sight so as to form the result already given in figs. 16 and 18.

Lastly—if without using the plane, three objects A, B and C, be placed in the median line of sight, and the eyes be fixed upon the middle one B (fig. 21), then by the *usual* mode of representation the position of the double images of A and C will be *a'a*, *c c'*; the lines here representing of course not visible lines but only lines of direction. But if using the plane we draw a *visible* line in the direction of the median line, and upon it place three pins at A, B and C, (fig. 22), and connect these points with R and L, also by visible lines, and then direct the eyes upon B, the falseness of the former mode of representation becomes at once evident. The visual result of this experiment is shown in fig. 23. Every line of this somewhat complex figure can be distinctly seen. By comparing the two modes of representation (figs. 21 and 23), it will be seen that the parallactic position of the double images, or their position when referred to the plane of B, is the same (the dots represent these positions in fig. 23), but only the second mode (fig. 23) represents truly their apparent distance.

Thus there are two apparent movements of the visual fields accomplished by the eye (or the mind) in binocular vision: 1st, in a *passive state*, a *shifting* of each field one-half interocular space to the opposite side, so as to bring the two visual lines together to form a *true median* visual line; this movement is involuntary and habitual: 2d, in *ocular convergence* a *rotation* of each field in a direction opposite to the motion of the eye, on a line passing through the eye normal to the visual plane; this takes place in every *voluntary* act of sight. In all other movements of the eyes, as when we look from side to side or upward or downward, *objects* seem *stationary*, and we are conscious of the movement of the visual lines over them; but when the optic axes move toward each other as in convergence,

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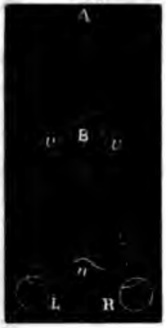

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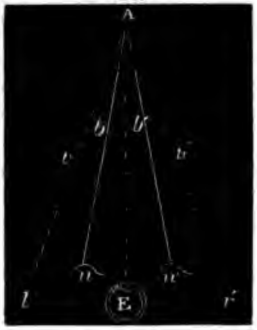

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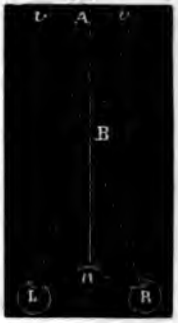

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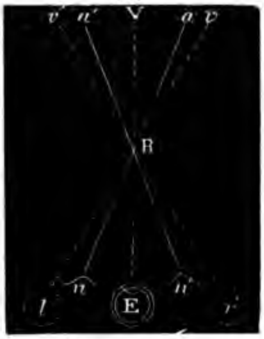

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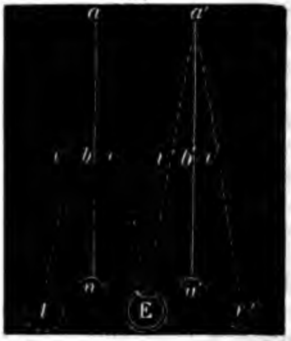

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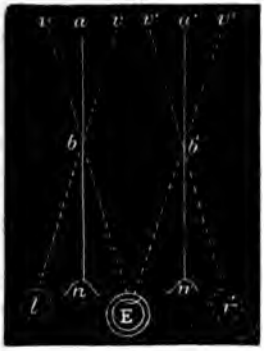

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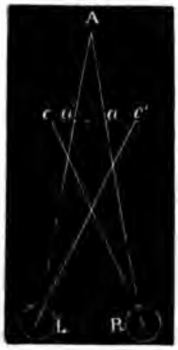

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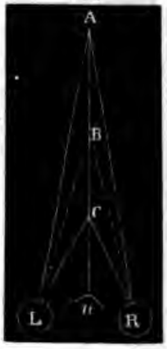
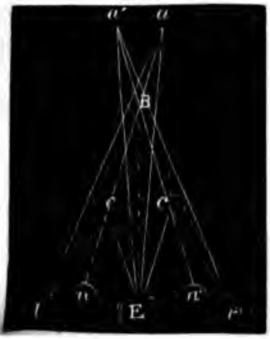
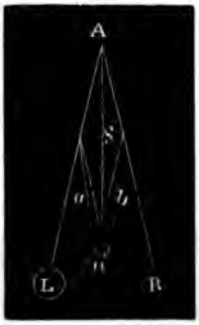


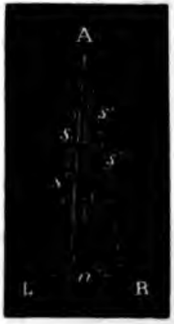
23.



24.



25.



all objects or images in the fields of view seem to move while the visual lines seem stationary. As the visual line of the right eye moves to the left all the images in its field seem to move to the right, and as the visual line of the left eye moves to the right all its images move to the left. Thus as the visual lines of the two eyes pass successively over objects in the external world right and left of the median line, the images of these objects move forward, and successively take position *directly in front*; so that under all circumstances the two visual lines combine to form a *median* visual line passing through the point of sight and onward to infinity. In case the images thus brought together are *similar*, as in my previous experiments, they combine, and are seen single at the point of sight; but otherwise they maintain their relative distances. This is especially true when we look at continuous lines on a plane parallel to the visual plane, as in the experiments detailed above. The fields rotate toward each other and images come together on the median visual line, but maintain their relative distances from the observer.

I might multiply experiments of this kind without number, but I wish now to show into what singular confusion some of the most careful observers have fallen by adopting the usual mode of representation. I will give first an experiment of Claparède which, according to him, is only a confirmation of what had been previously observed in the last century by Robert Smith, again in 1818 by Vieth, and again in 1838 by Wheatstone. It is therefore well fortified by great names. I translate:*—"Take a compass widely opened (fig. 24), apply its head to the root of the nose, holding the branches in the plane of vision. The screen S is so disposed that the left eye L sees only the branch *a*, and the right eye R only the branch *b*. If now we press the branches until the points are brought on the optic axes, (the point of sight being at A) as indicated in the figure (fig. 24); *we will perceive a closed compass* between the images *s s s's'* of the screen (fig. 25), and this compass stretches itself even to the point of view A." Now I have repeatedly tried this experiment and I find the visual result entirely different. This result is shown by my mode of representation in fig. 26. It is *two half compasses united at the point and separated at the head, by the whole common field of view*. It cannot be otherwise, since we must see two noses bounding the common field of view on each side, and the head of the compass resting on the nose must be similarly doubled and the images similarly separated. As to *length*, the compass may be imagined of *any extent* short of the point of sight A. If the compass is placed *exactly* in the plane of vision, the experiment succeeds equally well without the screen, for in that case only the right branch can be seen by the right eye, (the left branch being covered by it), and the left branch by the left eye. If the compass be placed a little below the plane of vision, so that both branches may be seen by each eye, or better if it be laid on the plane before described as in fig. 27, then the visual result will be represented by fig. 28.

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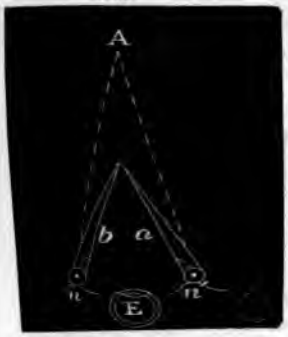
* Bib. Univ. Archives des Scien., II. Tome 3, p. 264.

The error in the interpretation of this very simple experiment, is due to the difficulty which most persons, even good observers, experience in separating what they *know* from what they *see*. In this experiment we *know* that the nose is in the middle between the eyes; we *know* also that the head of the compass is on the nose; and we *see* that the two points of the compass are together, therefore we *imagine that we see* a closed compass stretching from the nose to this point. But this is not only different from what we really see when our visual impressions are properly analysed, but is contrary to the first principles of binocular vision. The head of the compass impresses the extreme temporal limits of the retinæ of the two eyes, and must therefore not only be seen double, but *the double images are separated by the whole common field of view*. It seems almost incredible that images so widely separated should be imagined single.

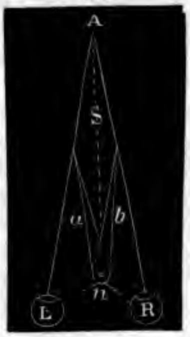
Again: in Guy's Hospital reports is found an elaborate series of papers on the "Physiology of Vision," by Joseph Townes, extending through 8 vols., viz: 3d ser., viii and xv inclusive. Mr. Townes' experiments are performed with great care, many of them with the apparatus, and in the manner, already described. He has also *in most cases* truly described and truly drawn his visual impressions, *as far as he has distinctly perceived them*. But on account of the faulty mode of representation he seems to have neglected one half of the visual impressions which he ought to have perceived. His papers also show misconception on some fundamental points in binocular vision which I cannot now notice. I wish now only to compare his visual results with my own, and thus to show the superiority of my mode of representation. Among his many figures I will select only two, as the principles involved are precisely the same in all.

In the accompanying figure (fig. 29) I reproduce his drawing fig. 1. Pl. I, only changing the lettering so as to bring it into accord with the previous figures of this paper. The visual result which he obtains when this drawing is viewed on the plane already described, the point of sight being at A, is given in fig. 30. In this result V is the combined visual lines *v r* and *vl*, *b* is the median line B of the drawing, as seen by the right eye, and *b′* the same line as seen by the left eye, but the right eye image of *v l* and the left eye image of *v r* are entirely overlooked.

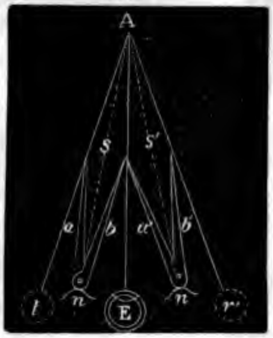
26.



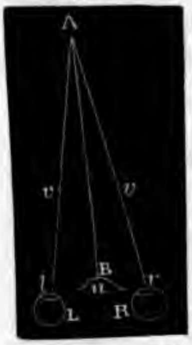
27.



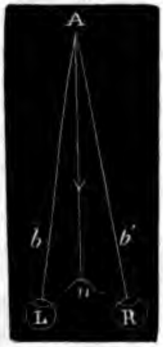
28.



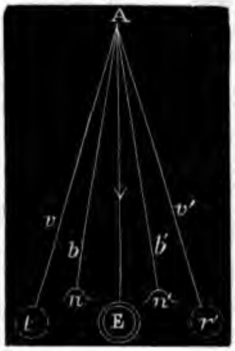
29.



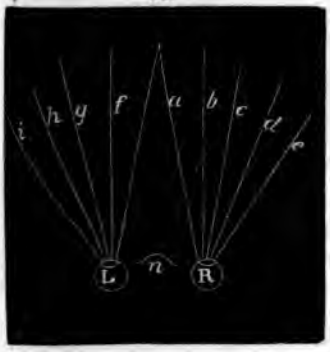
30.



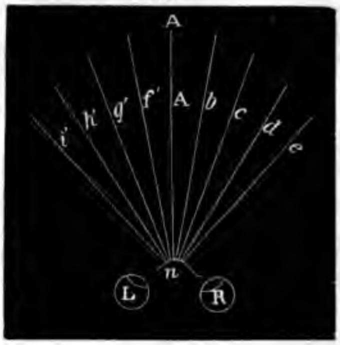
31.



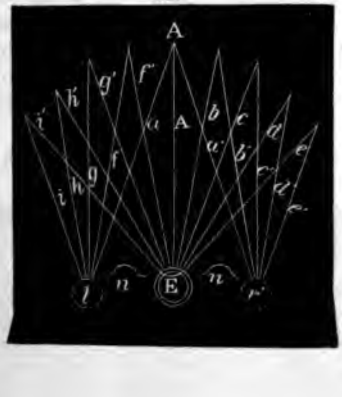
32.



33.



34.



The result which I obtain is given, represented by my method, in fig. 31.

In fig. 32, I reproduce one of his more complex drawings, viz: fig. 1 of his Pl. II, lettering of course as before. The visual result which he obtains by viewing this figure with the point of sight at A is given in fig. 33, where A *n* is the combined lines A R and A L of the drawing, *b c d e*. The corresponding lines of the drawing, as seen by the right eye alone, and *f' g' h' i'* corresponding lines of the drawing as seen by the left eye alone. My result is given in fig. 34. By careful comparison of these two results, remembering that capitals represent combined images, small italics right-eye images, and dashed italics left-eye images, the nature of their differences will be readily understood. Mr. Townes in his result makes the right eye shift to the left *only the right portion*, and the left shift to the right *only the left portion*, of the drawing. My result shows the *whole drawing* shifted by the right eye to the left and the left eye to the right. Mr. Townes has neglected entirely the left eye images of *b c d e*, and the right eye images of *f g h i*. Every one of his visual results of figures drawn on the plane described, except a few in which he used a median septum, are faulty in the same way, and may be reconstructed on the same principle, with the utmost certainty, even before performing the experiment.

Oakland, Cal., Sept. 27, 1870.

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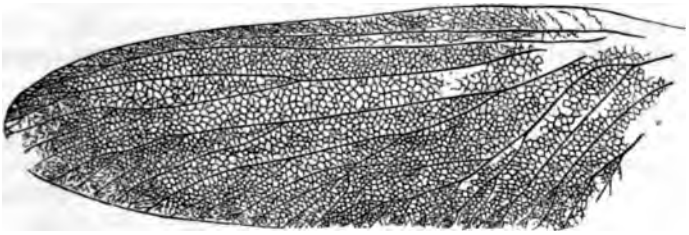
## ART. IX.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. IX.—*Notice of a Fossil Insect from the Carboniferous formation of Indiana;* by SIDNEY I. SMITH.

### *Paolia vetusta*, gen. et sp. nov.

THE fossil insect wing, represented in the accompanying figure, was sent for examination and description, from the Museum of Hanover College, Indiana, by Prof. E. Thompson Nelson. It occurred in the "grit" quarry near Paoli, Orange county, Indiana, and was discovered by the workmen while sawing the stone into small pieces for whetstones. The fossil is remarkably perfect, nearly the entire wing being beautifully preserved, and of peculiar interest for showing the complete wing-skeleton of an insect so ancient as the coal period. It is apparently the anterior wing of the left side, and measures 2·54 in. in length and about ·85 in. in breadth, the posterior margin being slightly cut away by the saw.

Along the anterior border, the space between the second and third nervures is bent abruptly downward in the specimen, so as to be somewhat foreshortened as seen in the figure. This is probably a natural fold such as is found in many Neuropterous insects.



The neuration is remarkable for the number of slender branchlets which the nervures throw off toward the posterior border and the tip of the wing. The first, or marginal, nervure* is continuous to the tip of the wing. The second is simple and straight nearly to the extremity, where it throws off several very minute branchlets and itself impinges upon the margin, about three-fourths of an inch from the tip of the wing, as a very delicate nervure. The third divides a short distance from its origin; the anterior branch runs parallel to the second nervure, is separated from it nearly as far as the second is from the first, and is simple to near its extremity, where it is twice forked, the minute branchlets reaching the margin a little way from the tip of the wing; the lower branch is broken and wanting just at its origin; it forks about the middle of its course, the anterior of these secondary branches again subdividing like the anterior primary branch, while the posterior secondary branch divides about the middle of its course, the anterior of these tertiary branches again dividing near its base, and the anterior of the branchlets reaching the margin at the apex of the wing. The fourth nervure divides a third of the way from the base to the tip of the wing; both these branches fork or branch several times, so that there are twelve branchlets extending from them to the margin, and one from the posterior, or inner, side which is lost in the space between the fourth and fifth nervures and does not reach the margin. The fifth divides near the base of the wing; the inner branch runs an almost straight course to near the margin where it divides; the outer primary branch divides about the middle of its course, both its branches again dividing or branching several times, and the first branchlet on the outer side not reaching the margin. The basal portion of

Figure 1, is once and a half natural size lineally, and was drawn on wood from a photograph.

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* For convenience of comparison, I follow Heer's notation of the main nervures of the Neuropterous wing, as adopted by Mr. Scudder, regarding what are usually considered the primary branches of the median as distinct nervures, making six in all.

the sixth nervure is wanting in the specimen, but undoubtedly divides at its origin. The outer branch forks a short distance from the margin, and the outer of these branchlets, and probably the inner also, again fork very near the margin. The inner branch forks about the middle of its course, both these secondary branches forking once or twice.

All the interspaces are filled by a finely reticulated and very delicate net-work of minute nervures, but there are no straight cross-nervures. There is, however, a series of nervures running from the second nervure to the anterior margin, which are stronger than the general net-work, but still seem to be a part of it.

This wing differs so much in neuration from any family of recent insects, that it is difficult to point out any near affinity with living forms, although it shows some points of resemblance to several families of Neuroptera, and especially to the Ephemerids. To *Hemeristia* and *Miamia*, described and figured by Prof. Dana[*] and Mr. Scudder,[†] from the Carboniferous formation at Mazon creek in Illinois, it shows more resemblance, but still differs more from either of these genera, which are considered distinct families by Mr. Scudder, than they do from each other. From the forms described by Mr. Scudder in the third volume of the Geological Survey of Illinois, it is even more widely separated.

To the species described from the European Carboniferous, it seems to be still more closely allied. Prof. Hagen, to whom a tracing of the specimen was sent, is of the opinion that it will be found to belong to the same genus as the *Dictyoneura libelluloides* of Goldenberg.[‡] Prof. Hagen, also, regards the remarkable *Eugereon Böckingi* Dohrn,[§] which has attracted so much attention, as the same genus, and perhaps the same species, as *D. libelluloides*. In both *Dictyoneura* and *Eugereon*, as figured, the wings have considerable resemblance to the specimen from Indiana, but in neither of them are the nervures so numerously branched toward the posterior border of the wing, and in *Eugereon* the spaces between the three first nervures next the anterior border are connected by straight cross-nervures. There are also important differences in the branching of the main nervures. Regarding these differences as at least of generic value, I propose to institute a new genus for the species from Paoli, and call it *Paolia vetusta*.

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[*] This Journal, vol. xxxvii, pp. 34, 35, figs. 1, 2, 1864.

[†] This Journal, vol. xl, p. 268, 1865, and Memoirs Bost. Soc Nat. Hist., vol. i, p. 173, pl. 6, 1866.

[‡] Die fossilen Insecten der Kohlenformation von Saarbrücken (aus den Palæontographicis von Dunker und Meyer, Band iv, 1854), pl. 1.

[§] Eugeron Böckingi, eine neue Insectenform aus dem Todtliegenden (aus Palæontographica von Dunker, Band xiii, 1866, pl. 41.

## ART. X.—*Earthquake of October 20th, in Northeastern America;* by ALEX. C. TWINING.

NOTICES of the earthquake of October 20th last, collected from the newspapers and received from other sources, display an area of disturbance extending from New Brunswick in the East, to the State of Iowa in the West, and from the Lakes and the River St. Lawrence in the North, to Cincinnati and Richmond, Va., in the opposite direction. No doubt the actual area of disturbance was far more extended, especially in the East and North; for the manifestations were at least as strong in degree at the utmost bounds of our information in these last directions, as in those parts with which we are most immediately familiar. The same conclusion is confirmed by the circumstance that, even where the motions were most fully developed, they were not obvious to persons not favorably situated for receiving impressions from them. It is easy to believe that they escaped public attention over large regions where they took place sensibly, although but feebly.

At this place—New Haven, Connecticut—the movements, both in the precise time of their occurrence and in the attendant circumstances, were immediately and critically investigated by the writer, from the testimony of many intelligent citizens. Independently, and in their various situations and positions, the witnesses agreed in describing an oscillatory movement, to and fro, in the general direction of N.N.E. to S.S.W.,—not level but rocking. This last sensation is plainly indicative quite as much of a vertical displacement, combining irregularly and oppositely with the horizontal, as of any alternations of inclination in the earth's surface, after the manner of a wave, and a consequent vibratory condition of persons and objects. Still, that the latter did take place is a conclusion that seems to be made inevitable, by the invariable fact that the oscillations were by far the most perceptible in lofty situations,—for example, in the ascent progressively from the lower floors of edifices to the upper stories. In the latter, at least, objects were both felt and seen to be in motion; and suspended objects, as lamps and pictures, were set into vibration, with a range of three or four inches and, when free, in the direction already specified. There were two distinct shocks. In estimating the duration of these and of the interval between them, and also in estimating their component oscillations, these durations and intervals were in no case recorded from mere verbal statements, but means were employed to ascertain the informant's *mental* impressions and recollections, applying to them my own measurement, as to time.

These impressions and recollections would often give durations more than double, in some instances, of the like in other instances. Taking, however, the most trustworthy, and allowing to the others a weight proportioned to their value, under the circumstances, the first shock was found to have continued through about nine seconds, the second through about eleven seconds, and the interval about five,—making, altogether, twenty-six seconds. The time of each double vibration—that is both to and fro—was concluded to approximate to a second and one-third,—although, so far as mere numbers were concerned, the witnesses more generally approved not more than one second, or even less. The precise time of day will be referred to farther on. It is remarkable that motions which were not even noticed, ordinarily, by persons in basement stories or in the streets, should have produced in most of those who felt them nausea or dizziness or other affections, according to the temperament of the individual.

A careful comparison of the various newspaper paragraphs which have come to hand—nearly forty in number—makes it clear that the general phenomena were everywhere the same. Every where there were two shocks experienced of a few seconds each, and a brief interval. These are about as variously stated in duration by the newspapers as the same were stated by different observers at New Haven:—thus, at Troy 15 to 20 seconds in all, at Montpelier 30, at Cleveland 15 to 30, the prevalent authority being for the latter, at Boston 18 to 30, at Brunswick, Me., 30 to 40, at Cincinnati 30 and less, at Hartford 20 to 60, at Cornell University, Ithaca, three shocks of 15 seconds each—the *three* being too exceptional among the mass to be credited, and having but one other parallel, that is, Brooklyn. At Harvard College Observatory the duration of tremor was from 8 to 15 seconds by the estimate of different observers,—two shocks with a continuous tremor between, and the component oscillations 40 in a minute according to observer W. A. Rogers. At East Saginaw, Mich., the first shock is described as 10 seconds, then an equal interval, then a second shock of 10 seconds. A very few of the statements are so abnormal, one or two in their brevity (one or two seconds) and about as many in their length (two or three minutes), that no weight can be accorded to them. On the whole, the entire duration—26 seconds—at New Haven, is confirmed as having been about the duration in all other places observed—a uniformity probable in itself. In one instance the oscillations are spoken of as four or five in a second, and as being like the motions of a boat,—also in one other (at Keene) they are described as having been vertical.

Respecting the relative amount of disturbance at different places, the sensations experienced by individuals would be but

lacious test, because so much influenced by temperament,
ell as by situations and positions. Persons sitting, for ex-
le, were far more sensitive than persons standing. Again,
e operatives in upper rooms often rushed down—as here at
Haven—in a panic, persons standing or walking in the im-
iate vicinity below, did not even perceive the phenomenon.
same remark applies to the reported swaying of walls and
lings ten inches to a foot, which is no doubt exaggerated
mount. But a vague conclusion may be derived from
fic occurrences, such as the displacement of objects, the
cing of window panes or of ceilings, and the falling of
neys, as well as from the degree of public notice which
vent excited. All that, in the present instance, can be ration-
deduced from such indications would seem to be that the
unt of disturbance at New York, at Cleveland, at Mil-
kee and Detroit was about the same as at New Haven;
it was greater at Boston, at Brunswick, at Montreal and at
bec; that it was less at Cincinnati, at Chicago, and at Du-
ue, and was but just distinctly perceptible at Richmond, Va.
ther words, the movement was more remarkable in the East
North, and less in the West and particularly in the South.
also believed that no like occurrence comparable in the
egate with this one has been experienced in New England
ng the present century, nor since November 18, 1755—
osing the newspaper quotation, relative to that event, made
Boston correspondent, from "a book published in 1786"
e correct and authentic.

only remains to compare the times noted at the various
es concerning which our information is sufficiently authentic.
his place there were two among the observers who separately
d the time by reference to standard time-pieces. By each
ame time of beginning was given, within a few seconds;—
is, $11^h\ 19^m\ 46^s$. The average of three other observations
ime-pieces whose errors could not be ascertained except on
lay after, proved to be very nearly the same. The same
lusion was farther confirmed, with sufficient exactness, by
verage of three clocks which had stopped, as observed upon
dials. Prof. C. Smallwood of Montreal Observ'y has oblig-
y furnished observations of local time in the Canadas which
ntitled to confidence, viz., at Quebec, Montreal and Owen's
nd, and also at St. Johns, N. B. These will be found in
place in the table below. The time at Boston, taken by
Farmer with care, is communicated by Prof. Newton, to-
er with most of the newspaper notices herein referred to.
at Harvard College Observatory has been obligingly fur-
ed to the writer by Assistant Arthur Searle, together with
ther facts herein stated as observed at that locality. The

time at Cleveland, Ohio, is the average of three clocks that were stopped, and is confirmed essentially by Col. Whittlesey, but without an actual reference of either to a standard time-keeper. From these combined the following table is composed; of which column 1 gives the place of observation; column 2, the latitude; column 3, the difference of local time from New Haven corresponding to the longitude; column 4, gives the respective local times corresponding to $11^h\ 19^m\ 46^s$—the beginning at New Haven; column 5, is an empirical scale of progress proportioned to the differences of longitude and the presumed differences of absolute time at St Johns and Chicago; column 6, gives the observed times of the earthquake; column 7 is comparative of the two preceding, and shows the presumed error of observation, whether too late or too early at each of the places respectively. It would obviously only obscure the discussion to take account in the table, of times which do not purport in the notices themselves to be near approximations, or which are adopted from the railroad time-pieces without supplying the proper correction, or which are found by comparison with the mass of observations to be grossly in error. To one or the other of these categories belong the notices from Brunswick and Portland, Me., Burlington, Vt., Warrensburg, Saratoga, Cooperstown, Cornell University, and Auburn, N. Y., Scranton and Titusville, Pa. The notice from Cincinnati, Ohio, is retained on account of the extreme position.

| 1. | 2. | 3. | 4. | 5. | 6. | 7. |
|---|---|---|---|---|---|---|
| Place of Observation. | Lat. of place. | Time diff. from New Haven. | Simultaneous local Times. | Empirical Times. | Observed Times. | Diff. early or late. |
| | ° ′ | m. s. | h. m. s. | h. m. s. | h. m. | m. s. |
| St. Johns, N. Bruns. | 45 9 | +27 34 | 11 47 20 | 11 45 5 | 11 45 | 0 5 early. |
| Bangor, Me. | 44 48 | +16 34 | 11 36 20 | 11 34 55 | 11 35 | 0 5 do. |
| Lewiston. Me. | 44 5 | +10 46 | 11 30 32 | 11 29 33 | 11 30 | 0 27 late. |
| Boston, Mass. | 42 21 | + 7 28 | 11 27 14 | 11 26 30 | 11 25½— | 1 1 early. |
| Harv. Coll. Obs'y. | 42 23 | + 7 11 | 11 26 57 | 11 26 14 | 11 25⅘+ | 0 25 do. |
| Quebec, L. C. | 46 49 | + 6 38 | 11 26 24 | 11 25 44 | 11 27 | 1 16 late. |
| Providence, R. I. | 41 50 | + 6 7 | 11 25 53 | 11 25 15 | 11 26 | 0 45 do. |
| Norwich, Conn. | 41 33 | + 3 14 | 11 22 50 | 11 22 25 | 11 20 | 2 25 early. |
| Montpelier, Vt. | 44 17 | + 1 18 | 11 21 4 | 11 20 48 | 11 24 | 3 12 late. |
| Hartford, Conn. | 41 46 | + 0 59 | 11 20 45 | 11 20 30 | 11 20½+ | 0 4 do. |
| New Haven, Conn. | 41 18 | 0 0 | 11 19 46 | 11 19 36 | 11 19¾+ | 0 10 do. |
| Montreal, L. C. | 45 31 | — 2 38 | 11 17 8 | 11 17 7 | 11 17 | 0 7 early. |
| Dudley Obs., N. Y. | 42 40 | — 3 20 | 11 16 26 | 11 16 31 | 11 15 — | 1 16+do. |
| Hudson, N. Y. | 42 14 | — 3 22 | 11 16 24 | 11 16 29 | 11 14 | 2 29 do. |
| Schenectady, N. Y. | 42 48 | — 4 0 | 11 15 46 | 11 15 54 | 11 15 | 0 54 do. |
| New York. | 40 43 | — 4 20 | 11 15 26 | 11 15 35 | 11 15 | 0 35 do. |
| Warsaw, N. Y. | 42 43 | —20 58 | 10 58 48 | 11 0 18 | 11 0 | 0 13 do. |
| Toronto, U. C. | 42 40 | —25 44 | 10 54 2 | 10 55 48 | 10 55 | 0 48 do. |
| Owen Sound, U. C. | 44 44 | —32 2 | 10 47 44 | 10 49 58 | 10 52 | 2 2 late. |
| Cleveland, Ohio. | 41 30 | —35 10 | 10 44 36 | 10 47 5 | 10 44⅔ | 2 25 early. |
| Cincinnati, Ohio. | 39 6 | —46 6 | 10 33 40 | 10 37 8 | 10 30 | 7 38 do. |
| Chicago, Ill. | 42 0 | —58 38 | 10 21 8 | 10 25 23 | 10 25 | 0 23 do. |

From all observed times of the *end*, if expressly so given, twenty-six seconds has been deducted for the *beginning*, as above. Wherever no mention is made of the period in the shock to which the observation applies, the times stated in the notices respectively have been inserted in the table without change, as being the presumed time of the beginning.

An inspection of this table discloses no considerable north-and-south movement. A nearly east-and-west progress is that which appears most consistent with the aggregate of times. Indeed it presents itself as the only one at all consistent with a uniform and regular progress. Nor is there discovered in the table any decisive indication of a change of direction as between the east and the west of the Alleghanies; but the various accounts, so far as they go, indicate the very reverse. Thus the direction of N.E and S.W., noted at Brunswick, was accurately N. 10° E. at Harvard Observatory, while it was N.N.E. at New Haven, and almost identically the latter also at Chicago. But at Cleveland and Detroit it is described as E. and W., and at Burlington, Vt., N. and S. One account from Boston makes it, incorrectly, N.W. and S.E., and another from Hartford the same at the latter place.

The best approximate result appears to be that the earthquake made progress from about E. 6° N. to about W. 6° S., *at the rate of one hundred and sixty miles a minute*, being six minutes and a half from St. Johns to Chicago; *while surprisingly, the ordinary direction of the subordinate undulation was about N. by E.* But there was not absolute regularity of rate in any single direction. The times at Cambridge, at Albany and at New Haven compared together, disclose appreciable deviations from the general *regimen* of the table; and the same is probably true with respect to the Cleveland observation. Unfortunately the latter was not checked by comparison with a standard time-piece,—neither, as is probable, was the Owen's Sound observation. That at Cincinnati does not purport to be more than a loose approximation.

It appears by observations of Prof. Hough at Dudley Observatory, obligingly furnished me by him, that the principal shock was observed at $11^h 15^m$, being a few seconds in duration, but that a tremor continued for at least a minute. No doubt there exist, at various localities not heard from, many observations recorded or distinctly remembered. It is desirable yet to have them communicated to this place, or to some one elsewhere, by whom they will be made available.

In fact while this article is in press, I am furnished through the favor of H. Paton, Esq., of the Montreal Telegraph Co. at Quebec, with the following important statements by Mr. Robert McCord, the operator who made inquiries immediately after the cessation of the earthquake at that office, and received replies from Montreal. His condensed statements are: "All perceptible motion was over here by the time I had finished telegraphing to Montreal—*do you feel earthquake.* It would take about eight seconds to telegraph the words used. The operator's immediate reply was—*no.* About fifteen seconds after, he said —*here it is.* The gentleman at Montreal afterward explained that, although he said *no*, he did experience a slight movement at the time, but was not aware that it was caused by an earthquake. He telegraphed—*here it is*—on the instant that the shock became sensibly evident. He cannot say how long the vibration lasted after that period, accurately, but is of opinion it continued for nine or ten seconds. The following further particulars be may of interest. The shock passed over this district from a northerly direction,—a rumbling sound accompanied the shock, resembling that produced by ponderous machinery,—noise and motion increased steadily for some seconds, and gradually passed away. Buildings were violently shaken. Our office being in the upper part of a high brick building, the trembling was powerfully felt—the clock in the office was stopped by it at 11:25, but am not certain if the time by it previous to the shock was correct. Some observers say the shock was first felt here a few seconds before 11:24, and lasted forty seconds —others state fifty or sixty seconds. I am of opinion it lasted sixty seconds. No two opinions agree as to the commencement and duration."

"At Bay St. Paul and Les Eboulements—places about ninety or one hundred miles northeast of Quebec—the ground opened in several places, and water was thrown up. Slight elevations of land in some places were produced. The country in the vicinity of St. Paul's Bay is of volcanic formation, and slight shocks are of frequent occurrence. A gentleman from that vicinity informs me that they had twenty or thirty slight shocks within the past two weeks. The shock on the 20th, here, did not appear to have an undulating, upheaving motion, but to partake of a tremulous nature."

"The operator at Richmond, a place ninety miles southwest of here, says the shock was just passing away there at the period when I made the inquiry of Montreal."

Mr. McCord does not refer to specific authority for the convulsive effects at Baie St. Paul and Les Eboulements, some 55 to 62 miles in a direct line from Quebec; but they are in general conformity to what has long been known to British geologists respecting the volcanic character of the region specified. They, in fact, recall and confirm the representations made at page 236, vol. xxx of this Journal, 1836, in a paper by Capt. R. H. Bonnycastle, R. En. In that region, very probably, lay the initial of the disturbance. The subject, in this view of it, merits re extended investigation, and it is hoped that the state- here brought out will induce new communications relative e facts.

ie interpretation of Mr. McCord's interesting statements ive to the telegraphic communication, seems to be as fol- : He occupied the last eight seconds of the motion at Que- with a question put to Montreal. That question, together the answer "no," I find by careful trial at the American graph office. require not less than eighteen seconds for mission and reception. Then there are estimated fifteen ids of interval. Then there was the second reply of not than eight seconds; then there were nine or ten seconds to nd of the vibrations. In other words, there transpired not than forty-two seconds between the end of the message and e tremors at Quebec, and the end of the same at Montreal, ty-six miles distant in longitude, and one hundred and fifty- in a line N. 51° E., and which in the table above had been still remains credited with the empirical interval of thirty- seconds,—showing a near accordance between these and other facts, and 137 miles per minute of east-and-west pro-

gain, the Montreal "no" was given just as the tremors there n, and after—say six seconds after—the end of the shock uebec; that is to say, the beginning traversed from city to in some six seconds more than the duration of the shock. sequently the latter, in consistency with the above, must continued about thirty-six seconds, in place of the twenty- seconds ascertained at New Haven. Still again, the shock Iontreal began with the "no," which may have occupied seconds. Then there were fifteen seconds of interval; eight of reply; then nine to ten of estimated continuance; l thirty-six or thirty-seven seconds for the duration of the k. The principal movement at Montreal did not come till ast fifteen seconds after the beginning; and the testimony he Richmond operator shows that the violence of the shock had passed, while the tremors at Quebec were still in continuance. Finally, it will be observed that the time ccurrence stated by Mr. McCord and others—although not irmed by his comparison with any standard time-piece— to represent the actual occurrence at Quebec to have been re the empirical time of column 5 in the table, instead of 6$^s$ later, as shown in column 7.

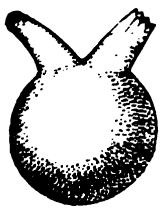
## ART. XI.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. X.—*Descriptions of some imperfectly known and new Ascidians from New England;* by A. E. VERRILL.

### *Molgula Manhattensis* Verrill. Figure 1.

***Molgula Manhattensis*** **Dekay, Report on the Natural History of New York, Mollusca, p. 259, 1843; Binney, in Gould's Invertebrata of Massachusetts, 2nd ed., p. 25, 1870, (copied from Dekay).**

BODY somewhat oval, subglobular, or slightly cordate, usually somewhat compressed laterally; when crowded often slightly adhering together laterally and more or less deformed; usually adhering to eel-grass (*Zostera*) and various sea-weeds, or to the under side of stones, by the left side, or obliquely by the basal portion. The surface including the tubes is generally thickly covered with fragments of eel-grass, broken shells, particles of sand, and various kinds of debris so as to entirely conceal the surface and disguise the form; sometimes, however, in sandy regions the surface is nearly destitute of such covering. The integument is firm and thick, and when clean it is translucent and roughened throughout with minute, granule-like papillæ, which are larger and more crowded on the upper part and around the base of the tubes, where they often form small, rough, unequal verrucæ. The tubes originate on the upper side, a little apart, the distance between usually about equal to the diameter of the anal tube;* they are both rather long and diverge by curving outward from the base. The anal tube is smaller and somewhat longer than the branchial, usually about equal in length to half the diameter of the body, and tapers to the end, which is rounded and has a small square aperture, its sides, near the end and often below, are usually roughened by irregular, uneven papillæ. The branchial tube is shorter and stouter, widest at base, truncate at the end, with six, small, obtuse, rounded papillæ surrounding the orifice; outside of these there are six, short, triangular lobes; below these there is often an irregular circle of about six to twelve rougher papillæ, alternately larger and smaller, and sometimes other more irregular ones below, between the sulcations; these are, however, sometimes wanting, as in the specimen figured. In contraction the tubes form low, rough verrucæ, the anal often four-lobed, both covered with rough, irregular papillæ.

1.



The inner tunic, which is closely adherent to the outer, is smooth, pellucid, light greenish, the dark intestine and a reddish organ below it showing through.

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* The figure represents them as arising nearer together than is usually the case.

life the body and tubes are pale yellowish green or olive; ranchial orifice is sometimes surrounded within by a ring ll reddish brown, the six lobes have each a spot of dark n, with smaller ones between. The anal orifice is greenish w.

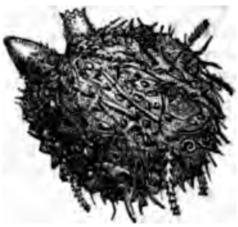
ameter of the largest specimens seen, about 1 inch.

w York Harbor,—Dekay; Fire I., Long Island, abundant l-grass,—S. I. Smith; New Haven Harbor, on eel-grass, dant,—A. E. Verrill; near New Haven Light on sea-weed, at Savin Rock, under stones at low-water mark,—A. E. ll.

*Molgula pannosa* Verrill, sp. nov., Figure 2.

dy subglobular, or a little elongated, somewhat compressed lly, entirely covered, except the ends of the tubes, with a and thick covering, composed of frag-s of shells, echini, zoöphytes, worm-, foraminifera, grains of sand, pieces a-weed, and other debris. The sur- of the integument, when the foreign r is removed, is densely covered with granule-like papillæ, which give rise ry abundant, long, fine fibrous pro-s, by which the foreign matters are en-ed; the basal portion of the tubes is ed with similar processes, though less numerous, which ase toward the end, leaving the terminal portion nearly th. The tubes, which arise close together, are short, con- a little divergent. The anal tube is a little longer than ranchial, swollen at base, tapering, and rounded at the end, h has a very small square aperture. The branchial tube out the same in size, but a little shorter, subcylindrical, ely tapering, with six, small, prominent, acute lobes or læ; alternating with these are six much smaller ones. In action the tubes can be wholly withdrawn, and then the looks like a more or less irregular ball of dirt.

2.



life the color of the clean integument is a dull, dark, gray-reen; the tubes lighter, or dull olive-green.

large specimen, when expanded, was 1 inch in length; ·75 l; ·50 thick.

stport, Me., 10 to 50 fathoms, muddy and shelly bottoms, peditions of 1868 and 1870; off Head Harbor, Campo I., 80 fathoms, muddy,—Expedition of 1868.*

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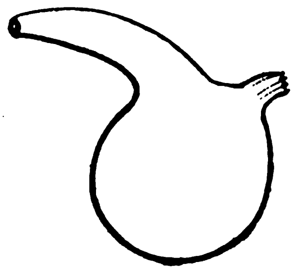
e expeditions of 1859 and 1863 were by the author; that of 1864 by the and S. I. Smith; that of 1868 by A. E. Verrill, S. I. Smith, H. E. Webster o. A. Jackson; that of 1870 by A. E. Verrill, Oscar Harger and C. H. lle.

### *Molgula retortiformis* Verrill, sp. nov. Figure 3.

3.



Body subglobular or more or less oval, generally higher than broad and a little compressed laterally, destitute of a distinct disk, though generally adhering. The integument is thick and firm, but translucent, usually covered, together with the tubes, by various zoöphytes, ascidians, fragments of shells, etc., which form a coarse, rough, and rather loosely adherent coating, but this is usually incomplete or thin and the surface more or less exposed. When cleaned the surface is roughened by small, scattered, granule-like papillæ, and irregular rough processes, while in large specimens it is more or less rudely wrinkled. The large tubes arise from the upper part, a short distance apart, and are widely divergent and very unequal. The anal tube is much the longest, usually equalling in length the diameter of the body, very large and swollen at the base, curving outward and tapering to the end, which is blunt, with a small square aperture, its surface is often roughened with irregular processes, and in partial contraction is often sulcated. The branchial tube is usually about one-fourth as long, much smaller at base, curved outward, the aperture surrounded by six, short, conical, acute papillæ or tentacular lobes, its surface below often rough with irregular verrucæ. In contraction the tubes form large, low and rough verrucæ, or may be wholly retracted and invaginated, together with a portion of the integument of the body around their bases.

When living the color is uniform light olive, or grayish green.

The larger specimens are often 1·50 inches in diameter; with the anal tube nearly 2 inches long; the branchial about ·50. In the collection there are specimens of all sizes from this down to less than ·25 of an inch in diameter.

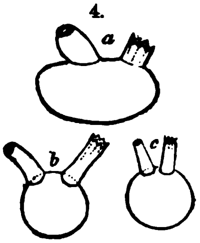
The young have essentially the same characters as the adults, but are smoother.

Eastport Harbor, South Bay, etc., from extreme low-water of spring tides to 50 fathoms, on rocky and shelly bottoms, adhering loosely by the sides, to other ascidians, zoöphytes, shells, etc., not abundant, though often met with,—Expeditions of 1864, '68, and '70; off Head Harbor, 80 to 120 fathoms,—Exp. 1870.

### *Molgula littoralis* Verrill, sp. nov. Figure 4, a.

Body transversely oblong-oval, somewhat flattened laterally, and attached obliquely by a part of one side (usually the right) to the under side of stones; when young subglobular. Integument firm and tough, but translucent, the tubes similar to the body; the surface smoothish in young specimens, in older ones slightly wrinkled, not fibrous, but somewhat roughened with sparse granule-like papillæ, to which a thin, imperfect coating of foreign substances is sometimes attached; in contraction the surface is reticulated with wrinkles, with more elevated interstices. Tubes short and stout, arising from the upper side, and separated by a distance about equal to or exceeding their diameters, quite divergent, the anal tube most so, not wholly retractile. The anal tube is about twice as long as the branchial and usually swollen in the middle, rounded at the end, with a simple square orifice, which in full expansion often becomes roundish. The branchial tube has about the same diameter, and is short, cylindrical, with six short conical papillæ around the orifice. In contraction the tubes form low verrucæ.

4.



When living the color of the body is translucent, dull greenish or olive, between the tubes usually more or less ferruginous brown, or russet; on the sides the viscera show through as dull orange-colored and darker blotches.

One of the larger specimens was, while living, ·45 of an inch long; height ·35; length of branchial tube ·10; diameter ·10; distance between bases of tubes ·08.

Eastport, Me., under stones near low-water mark, not uncommon,—Expeditions of 1868 and 1870.

In Binney's edition of Gould's Invertebrata of Massachusetts, there are three figures, reproduced from Mr. Burkhardt's drawings, which Mr. Binney refers somewhat doubtfully to *Glandula mollis* Stimpson, neither of which can represent that species. Of these, Fig. 317 (Pl. xxii) may, perhaps, represent the present species, but the apertures show no details.

*Molgula papillosa* Verrill, sp. nov. Figure 4, *b*.

Body free, nearly globular, or transversely suboval, usually slightly compressed laterally. Integument rather thin, translucent, the surface, both of the tubes and body, entirely covered by particles of sand, broken shells, foraminifera, etc., which adhere firmly. When cleaned the whole surface is thickly covered with prominent granule-like papillæ and numerous slender fibrous processes; the granules are most conspicuous on the tubes, where they usually have a rusty color. The tubes are long, subequal, and their bases are separated by a space usually greater than their diameters; they are quite divergent, both of them curving outward, the anal tube most abruptly. The branchial tube is cylindrical, somewhat longer than the anal, equal to or exceeding the diameter of the body, the orifice surrounded by six, rather long and slender, conical, divergent papillæ. The anal tube often bends suddenly outward, tapers slightly, and has a small square aperture, surrounded by a circle of dull reddish brown. In contraction the tubes are not retracted, but are usually shortened to about one-half their length. In life the body, when cleaned, is pale grayish, with an almost transparent integument, through which the convolutions of the dark intestine are conspicuous.

The largest specimens are about ·40 of an inch in diameter.

Eastport, at low-water mark under stones, and off the northern side of Treat's Island, in 10 to 20 fathoms, shelly bottom,—Expedition of 1870.

*Molgula pilularis* Verrill, sp. nov. Figure 4, *c.*

Body unattached, globular, covered with a thin layer of mud, and when the tubes are retracted, looking like a small soft ball. Integument of the body, when cleaned, very thin, soft, nearly transparent, thickly covered with minute granules, and minutely fibrous, usually concealed by the adhering particles of mud and fine sand, but this can be easily removed. The tubes are naked, smooth, nearly transparent, subconical, slender, nearly as long as the diameter of the body, originating close together, and but slightly divergent, both of them nearly straight; they can be wholly retracted and their bases are surrounded and connected by a narrow, naked, oval or oblong band, which is usually conspicuous when the tubes are withdrawn; in partial contraction, the tubes are conical, subpellucid, reticulated with white lines. The branchial tube is a little shorter than the anal, the aperture surrounded by six, acute, conical papillæ, and twelve, small, dark brownish spots. Anal tube a little smaller, slightly longer, a little tapering, with a small square aperture, surrounded by four small lobes and four small, reddish brown eye-spots.

In life the body, when cleaned, is transparent grayish, the dark intestine showing through very distinctly; tubes greenish at base.

Diameter usually about ·20 of an inch, seldom more than ·25 or ·30.

Eastport Harbor, in 10 to 20 fathoms, muddy, common,—Expeditions of 1864, '68, '70; South Bay, Lubec, in 6 fathoms, soft mud, very abundant,—Exp. of 1868; Grand Menan, off Swallow's Tail, 15 to 20 fathoms, soft mud,—Exp. of 1870.

*Cynthia glutinans* Möller (Kroyer's Naturhistorisk Tidsskrift, iv, p. 94, 1842) seems to resemble this species in form and appearance, but if it belongs to *Cynthia*, or to *Glandula* where Stimpson refers it, both apertures must be square. *G. mollis* Stimp. must be a closely allied species, if not identical.

(To be continued.)

# SCIENTIFIC INTELLIGENCE.

## I. CHEMISTRY AND PHYSICS.

1. *Thermo-chemical investigations.*—Under this title J. THOMSEN in Copenhagen, has published a series of valuable researches, the principal results of which, in the author's own language, are as follows:

(1.) As a general law it appears that for all acids

*a.* When a molecule of sodic hydrate in aqueous solution acts upon an acid the evolution of heat is very nearly proportional to the quantity of acid until this amounts to 1, ½, ⅓ or ¼ of a molecule, according as the acid is one-, two-, three-, or four-basic.

*b.* But when the quantity of acid exceeds that which is necessary to form the normal salt, a difference between the acids is exhibited, so that according to the constitution of the acid the heat* produced by its excess is either zero, positive or negative.

(2.) *a.* When a molecule of an acid in aqueous solution acts upon sodic hydrate the evolution of heat in a majority of cases is approximately proportional to the quantity of soda until this amounts to 1, 2, 3 or 4 molecules of sodic hydrate according as the acid is one-, two-, three-, or four-basic. The deviations from this law find an explanation in what is stated under heads 1—6.

*b.* But if the quantity of soda is increased above this, no material change occurs in the heat-toning.

(3.) If the magnitude of the molecule is determined in some other manner, the basicity of the acid, if indeed it has such, may be certainly found by this method of investigation.

(4.) From this it distinctly appears that sulphydric acid is monobasic and that its formula must be considered H.SH; since the second atom of hydrogen cannot in an aqueous solution be replaced by sodium. This result which at first sight appears strange is seen upon closer consideration to correspond completely with the more recent chemical theories, since on the one hand it perfectly explains the behavior of the acid, and on the other presents a material support to the theory of hydroxyl, as the great analogy between sulphur and oxygen renders it extremely probable that the formula of water must then be H.ΘH, and that water is to be regarded as a mono-basic acid. It follows also that the so-called neutral metallic sulphides, e. g., $Na_2S$, do not exist in an aqueous solution, any more than the corresponding oxides ($Na_2Θ$), and that the so-called sulphydrates, Na.SH, Ba.2SH, and Mg.2SH, are to be regarded as normal salts of the acid soluble in water.

(5.) Since the mono-basic acids contain only one atom of hydrogen replaceable by sodium, the second molecule of sodic hydrate must be without action upon the sodium salt, which is fully verified by experiment. Since further the mono-basic acids form no acid salts, an excess of acid must be without action upon the sodium salt, which is also verified by experiment. In strictness the second molecule of acid produces almost always a slight *toning* of the heat, generally an absorption of heat, but this amounts to only a couple of thousandths of the heat of neutralization. In the case of fluohydric acid we find an exception, since the second molecule of acid produces an absorption of two per cent of the heat of neutralization. This fact and the existence of the acid fluoride of sodium make it doubtful whether fluohydric acid belongs to the mono-basic acids. The numbers for meta-phosphoric and hypophosphorous acid also exhibit a slight toning of the heat (about 1 pr. ct.) for the second molecule of acid. But since the numbers for the first acid cannot be sharply determined in consequence of its great liability to change, and since the number for two molecules of the second were accidentally determined by only one experiment, I lay no stress on this deviation from the rule. In the case of fluohydric acid, however, the deviation is fully established.

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* In the original "Wärmetönung," *heat-toning*.

(6.) The bibasic acids which contain two atoms of hydrogen replaceable by sodium may be divided into several groups according to the quantity of heat which the first and second molecules of sodic hydrate evolve.

The first group embraces the bibasic hydrogen acids—fluosilicohydric acid, $SiF_6H_2$, and chlorplatinhydric acid, $PtCl_6H_2$; in these there is no noteworthy difference in the quantity of heat which the first and the second molecule of sodic hydrate produces; they behave therefore like the monobasic hydrogen acids, only the evolution of heat for one molecule of acid increases proportionably to the quantity of soda, up to the second molecule of sodic hydrate.

The second group includes sulphuric, selenic, oxalic and tartaric acids; in the neutralization of these acids the first molecule of sodic hydrate produces a less degree of heat than the second. The difference amounts to 5 to 1800 units.*

| Sodic hydrate. | Sulph. acid. | Selenic acid. | Oxalic acid. | Tartaric acid. |
|---|---|---|---|---|
| 1. Molecule, | 146 .. | 148 .. | 138 .. | 124 .. |
| 2. Molecule, | 164 .. | 156 .. | 145 .. | 129 .. |

The third group embraces sulphurous, selenious, carbonic and boric acids. In the neutralization of these acids the first molecule of sodic hydrate produces a greater degree of heat than the second: the difference amounts to from 18 .. to 28 ..

| Sodic hyd. | Sulphurous acid. | Selenious acid. | Carbonic acid. | Boric acid. |
|---|---|---|---|---|
| 1. Molecule, | 159 .. | 148 .. | 110 .. | 111 .. |
| 2. Molecule, | 131 .. | 122 .. | 92 .. | 89 .. |

In this group belong chromic acid, phosphorous acid and probably also succinic acid. In the reaction of the normal salts of the acids of the second group upon the corresponding acids an absorption of heat occurs, as is easily seen, while the normal salts of the acids of the third group produce in the corresponding reaction an evolution of heat.

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* Thomsen omits zeros and figures less than 100, and writes two dots only after the significant figures.

(7.) The tribasic acids exhibit differences similar to those of the bibasic acids, citric acid belonging to the second group, arsenic and orthophosphoric acid to the third. Thus we have

| Sodic hydrate. | Citric acid. | Arsenic acid. | Ortho-phosphoric acid. |
|---|---|---|---|
| 1. Molecule, | 124 .. | 150 .. | 148 .. |
| 2. Molecule, | 126 .. | 126 .. | 123 .. |
| 3. Molecule, | 132 .. | 83 .. | 69 .. |

Hence the second or third molecule of sodic hydrate evolves with citric acid *more*, with arsenic and ortho-phosphoric acid less heat than the first molecule. The difference in the evolution of heat in the second and third molecule of sodic hydrate is besides very large for arsenic and phosphoric acids.

(8.) The three groups which I have established in the class of bibasic acids, and of which two are found also in the class of tribasic acids, have their probable origin in the different constitution of the acids. In fact in the case of a bibasic acid the position of the two atoms of hydrogen replaceable by sodium may be conceived in three different ways. Thus sulphuric acid may be expressed by the following three formulas:

$$S\Theta_4 \left\{ \begin{matrix} H \\ H \end{matrix} \right., \quad S\Theta_3 \left\{ \begin{matrix} \Theta H \\ H \end{matrix} \right., \quad S\Theta_2 \left\{ \begin{matrix} \Theta H \\ \Theta H \end{matrix} \right.$$

The first formula might be most probable if the acid were a hydrogen acid; the second is most probable for an acid whose anhydrid exhibits a slight affinity for water; the third is the formula of a bibasic hydroxylic acid. The constitution expressed by the first formula probably corresponds to that of a bibasic hydrogen acid, as for instance fluosilicohydric and chlorplatinhydric acid.

$$Si\,F_6 \left\{ \begin{matrix} H \\ H \end{matrix} \right. \quad Pt\,Cl_6 \left\{ \begin{matrix} H \\ H \end{matrix} \right.$$

Sulphurous, selenious, carbonic, chromic and boric acids probably correspond to the second formula. Of these the first four at least easily and spontaneously split into anhydrid and water, so that the hydrates (acids proper) of several can scarcely be prepared at all. We have therefore for the rational formulas of these acids,

$$S\Theta_2 \,.\, \begin{matrix} \Theta H \\ H \end{matrix} \quad Se\Theta_2 \,.\, \begin{matrix} \Theta H \\ H \end{matrix} \quad C\Theta_2 \,.\, \begin{matrix} \Theta H \\ H \end{matrix}, \ \&c.$$

This corresponds entirely with the behavior of the homologues of carbonic acid, like glycolic acid and the other members of the lactic acid series, which are probably diatomic, but usually appear monobasic, as the second atom cannot be easily replaced by sodium, but readily by alcoholic and acid radicals. To the third formula correspond sulphuric, selenic, oxalic and tartaric acids, the formulas of which according with the usual assumption, become as follows:

$$S\Theta_2 \,.\, \begin{matrix} \Theta H \\ \Theta H \end{matrix}, \quad Se\Theta_2 \,.\, \begin{matrix} \Theta H \\ \Theta H \end{matrix}, \quad C_2\Theta_2 \,.\, \begin{matrix} \Theta H \\ \Theta H \end{matrix},$$

The analogy of the tribasic and bibasic acids leads for citric acid to the formula, $\text{Ȼ}_6\text{H}_5\Theta_4 \,.\, 3\Theta\text{H}$, while the formulas for the three modifications of phosphoric acid would be the following:

$$\text{HP}\Theta_3 \,.\, \genfrac{}{}{0pt}{}{\Theta\text{H}}{\text{H}},\quad 2\text{HP}\Theta_3 \,.\, \genfrac{}{}{0pt}{}{\Theta\text{H}}{\text{H}},\quad \text{HP}\Theta_3,$$

by which the thermic difference between citric acid and the acids of phosphorus and arsenic may be explained in harmony with the prevalent chemical theories.

(9.) Silicic acid is given in the tables (accompanying this paper) as a bibasic acid, but differs materially from the other acids of this group, by being absolutely without any definite point of neutralization. The numbers of table II show, it is true, that the heat which a molecule of the acid evolves with an increasing quantity of soda, increases only very slightly when this exceeds two molecules of sodic hydrate, and table I shows that the evolution of heat increases approximately in proportion to the quantity of acid, until this amounts to ½ molecule of silicic acid for one molecule of sodic hydrate. But table II shows at the same time that the numbers by no means increase in proportion to the quantity of soda, and table I also shows that the evolution of heat increases very materially for further additions of silicic acid. From what was shown in Section IV (Pogg. Ann., Bd. 137, p. 203), it appears that the maximum of heat which a molecule of sodic hydrate can evolve with silicic acid, and which occurs only when the quantity of acid is infinitely great, amounts to 134.. while for ½ molecule of silica it is only 26..; further, that the maximum of heat which is evolved by the action of a molecule of silica upon sodic hydrate, and which also occurs when the quantity of sodic hydrate becomes infinitely great, amounts to only 63.. while two molecules of sodic hydrate already evolve 52.. .

(10.) The anomaly in the neutralization of silica has very probably its cause in the simultaneous action of water and silica upon sodic hydrate. According to what has been said under 4, water is to be regarded as a monobasic acid, and sodic hydrate as its sodium salt. If now the sodium salt is attacked simultaneously by the two acids (water and silica), the base divides itself between the two acids in a ratio which depends upon the avidity of the acids and their quantity, (see Sect. 1, Pogg. Ann., Bd. 138, p. 94). If now the avidity of the water for the base is very small in comparison with that of the acid, this decomposes an approximately equivalent quantity of sodic hydrate, and the evolution of heat becomes therefore approximately proportional to the quantity of acid, as is also approximately the case with all other acids. If, on the contrary, the avidity of the water for the base is a quantity which cannot be neglected in comparison with that of the acid, the proportionality in the evolution of heat ceases, and then follows a law which holds good for partial decomposition, (see reference cited). The absorption of heat which takes place when a solution of sodic silicate (and also various other saline solutions) is diluted with water, has probably its cause partly in a partial decomposition of the salt by the water.

(11.) The quantities of heat evolved in the reaction of one molecule of sodic hydrate with one molecule of acid-hydrate in aqueous solution are very different. Fluohydric acid gives the greatest amount of heat (163..); then comes sulphurous acid (159..), hypophosphorous acid (152..), arsenic acid (150..); the different phosphoric acids, phosphorous, selenious, selenic and sulphuric acids give between 148.. and 144.. The evolution of heat is less in the cases of the hydrogen acids of chlorine, bromine and iodine and nitric acid (137..); much less in the cases of boric and carbonic acids (110.. to 111..) while sulphydric, silicic and cyanhydric acids give the smallest amounts of heat. If however we compare the evolution of heat which a molecule of sodic hydrate produces with the quantity of acid necessary to form a normal salt, the order of the series is somewhat different, but here also fluohydric acid occurs with the greatest quantity of heat (163..); then follow sulphuric, selenic and hypophosphorous acids (155.. to 152..), then sulphurous, hyposulphuric, phosphorous and oxalic acids (145.. to 141..), and so we pass gradually down to sulphydric, cyanhydric and silicic acids.

(12.) For some of the acids which I have studied the heat of neutralization had been determined already. The older investigations often show material differences from the numbers determined by me. The determinations of Favre and Silbermann in particular differ greatly. The results of these investigators for chlor-, brom- and iodhydric acids and for nitric and phosphoric acids are from 10 to 12 per cent too high, for instance for the first four acids 151.. to 152.. instead of 137... The cause very probably lies in the inaccurate indications of the mercurial calorimeter employed by them, and I doubt very much whether the experiments recently made with the same apparatus possess a greater accuracy. I have already found several material errors in the published results to which I shall return hereafter. For the rest I refer, with reference to the inaccuracy of the results obtained with mercury, to my communication in the Reports of the German Chemical Society at Berlin, 1869, p. 701. W. G.

## II. Geology and Natural History.

1. *Notes on the American Mastodon and other fossils;* by Dr. J. Leidy (Proc. Acad. Nat. Sci. Philad., Sept. 1870).—Dr. Leidy, after brief notes on the specimens of Mastodon in Boston and Cambridge, makes the following observations on some bones in the Museum of Amherst College.

Prof. Shepard has recently collected together many interesting fossil remains of vertebrates. Among these are a multitude of specimens obtained by his son from St. Helena Island, and the famous Ashley River deposits of South Carolina. Those from the latter locality consist mainly of Zeuglodons, Cetaceans and Fishes, but also include remains of Mastodon, the Elephant, and of *Equus Major* and *E. fraternus*. The St. Helena Island fossils consist of bones, fragments of jaws and teeth of the Mastodon.

Among them were noticed two inferior tusks, which measured about ten inches in length and two inches in diameter at the base.

The same collection contained a large molar of the American Elephant, of the coarse plated variety, from California. Some remains of Mastodon from the latter place struck me from their peculiarity, and these Prof. Shepard was so kind as to loan to me for examination and description.

One of the specimens, which lies on the table, is the fragment of a tusk from "Dry Creek," Stanislaus Co., California. It indicates a species totally different from the American Mastodon, and in its peculiarities exhibits a relationship with the *Mastodon angustidens* of the middle tertiary period of Europe. The fragment is six inches in length, is slightly curved in two directions, and in transverse section is ovate with the anterior pole acute. The pulp cavity, opening half the diameter at the broken base of the specimen, extends about half its length to the end. The convex side of the tusk possesses, as in *Mastodon angustidens*, a broad band of enamel, which reaches from the acute edge more than two-thirds the depth of the surface. The enamel is somewhat rugose and is two-thirds of a line thick. At one spot, toward the smaller end of the fragment, it has been irregularly worn through for the extent of about an inch and a half. The opposite side of the specimen, from the acute edge, has been worn off to an extent about equal to two-fifths of the surface. The broken ends of the fragment exhibit very conspicuously the beautiful arrangement of decussating curved lines so characteristic of the ivory in the tusks of the great proboscidians.

The vertical diameter of the base of the fragment is 28 lines, the transverse diameter 19 lines; the vertical diameter at the opposite end is 22 lines, the transverse diameter 16 lines. The entire length of the tusk appears to have been less then two feet.

The question arises as to what species the tusk fragment shall be attributed. It certainly does not belong to the common American Mastodon, nor is it probable that it belonged to the pliocene *Mastodon mirificus*. May it probably pertain to the hardly known *Mastodon obscurus?* In the present uncertainty I would look on the specimen as characteristic of a peculiar species allied to the *M. angustidens* of Europe. For the name of the species I would propose that of *Mastodon Shepardi*, in honor of Prof. C. U. Shepard, whose name has so long been identified with the interests of natural history.

The second specimen, exhibited to the members, consists of a fragment of a lower jaw containing the last molar tooth, and was discovered in Contra Costa county, California. No information in regard to the age of the deposit, or the character of the locality in which the fossil was found, accompanies it. The bone is friable, and measures, below the position of the tooth, five and a half inches in depth. Attached to the fossil there is a portion of soft gray rock, part of the matrix in which it has been imbedded. The tooth is perfect and well preserved. It has the same general form and constitution as the corresponding tooth of the American

Mastodon, but is considerably smaller. It bears sufficient resemblance to the plaster cast (represented in fig. 14, pl. xxvii., of "The Extinct Mammalian Fauna of Dakota and Nebraska, &c."). of a tooth, the original of which is lost, from a miocene formation of Maryland, to be viewed as pertaining to the same species. This I had named *Mastodon obscurus.*

The crown of the tooth consists of four transverse divisions together with the merest trace of a heel. As in the cast of the Maryland tooth, the inner lobes of the crown of the California tooth are more mammillary, and less angular than in *M. Americanus.* The outer lobes, likewise as in the Maryland tooth, have better developed offsets fore and aft internally than in the latter, giving rise to a greater degree of obstruction of the transverse valleys of the crown than in the American Mastodon. The fourth division of the crown is proportionately less well developed, in comparison with those in advance, than in the latter, agreeing also in this respect with the Maryland tooth. The outer lobe of this division is formed of a pair of connate mammillary tubercles, as in the latter, but the tubercles are more equally developed. The inner lobe is a single mammillary eminence not more than half the elevation of the outer lobe. In the Maryland tooth, the corresponding lobe resembles the outer one, consisting of a connate pair of tubercles as well developed as in the outer lobe. The heel in the California tooth, as in the Maryland tooth is formed by a short mammillary eminence occupying the angular space posteriorly of the lobes of the fourth division of the crown. A basal ridge is better developed externally in the California than in the Maryland tooth.

Comparative measurements of the California tooth, with the cast of the Maryland tooth, and one of the *Mastodon Americanus* are as follows:

| | California tooth. | Maryland tooth. | Mastodon Americanus. |
|---|---|---|---|
| Fore and aft diameter of the crown of the last molar tooth, | 6 in. 4 lines. | 6 in. 4 lines.[*] | 7 in. 3 lines. |
| Transverse diameter of do., | 2 in. 9 lines. | 2 in. 9 lines. | 3 in. 4 lines. |
| Depth of do. internally, | 2 in. 2 lines. | 2 in. 2 lines. | 3 in. 0 lines. |

It is not improbable that the California tooth may have pertained to the same species as the fragment of tusk previously noticed, and, perhaps these, together with the Maryland tooth, and others previously referred to *Mastodon obscurus*, may likewise belong to the same animal. The positive determination of this question must be left for the discovery of additional material to throw light on the relationship of the different specimens which have been thus far presented to our notice.

2. *On the cause of the Motion of Glaciers;* by J. CROLL, of the Geol. Survey of Scotland, (Phil. Mag., Sept., 1870).—Mr. Croll closes his article on the cause of the motion of glaciers with the following—*on the present state of the question*, and on the *alleged limit to the thickness of a glacier.*

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[*] Partially estimated, as the specimen is imperfect at its fore part.

*The present state of the question.*—The condition which the perplexing question of the cause of the descent of glaciers has now reached seems to be something like the following. The ice of a glacier is not in a soft and plastic state, but is solid, hard, brittle, and unyielding. It nevertheless behaves in some respects in a manner very like what a soft and plastic substance would do if placed in similar circumstances, inasmuch as it accommodates itself to all the inequalities of the channel in which it moves. The ice of the glacier, though hard and solid, moves with a differential motion; the particles of the ice are displaced over each other, or, in other words, the ice shears as it descends. It had been concluded that the mere weight of the glacier was sufficient to shear the ice. Canon Moseley has investigated this point, and shown that it is not. He has found that for a glacier to shear in the way that it is supposed to do, it would require a force some thirty or forty times as great as the weight of the glacier. Consequently, for the glacier to descend, a force in addition to that of gravitation is required. What, then, is this force? It is found that the rate at which the glacier descends depends upon the amount of heat which it is receiving. This shows that the motion of the glacier is in some way or other dependent upon heat. Is heat, then, the force we are in search of? The answer to this, of course, is, since heat is a force necessarily required, we have no right to assume any other till we see whether or not heat will suffice. In what way, then, does heat aid gravitation in the descent of the glacier? In what way does heat assist gravitation in the shearing of the ice? There are two ways whereby we may conceive the thing to be done: the heat may assist gravitation to shear, by pressing the ice forward, or it may assist gravitation by diminishing the cohesion of the particles, and thus allowing gravitation to produce motion which it otherwise could not produce. Every attempt which has yet been made to explain how heat can act as a force in pushing the ice forward, has failed. The fact that heat cannot expand the ice of the glacier may be regarded as a sufficient proof that it does not act as a force impelling the glacier forward; and we are thus obliged to turn our attention to the other conception, viz., that heat assists gravitation to shear the ice, not by direct pressure, but by diminishing the cohesive force of the particles, so as to enable gravitation to push the one past the other. But how is this done? Does heat diminish the cohesion by acting as an expansive force in separating the particles? Heat cannot do this, because it cannot expand the ice of the glacier; and besides, were it to do this, it would destroy the solid and firm character of the ice, and the ice of the glacier would not then, as a mass, possess the great amount of shearing-force which observation and experiment show that it does. In short it is because the particles of the ice are so firmly fixed together at the time that the glacier is descending, that we are obliged to call in the aid of some other force in addition to the weight of the glacier to shear the ice. Heat does not cause displacement of the particles by making the ice soft and plastic; for we know that the ice of the glacier is not soft and plastic, but hard and brittle. The shearing-force of the ice of the moving glacier is found to be by at least from thirty to forty times too great to permit of the ice being sheared by the mere force of gravitation; how, then, is it that gravitation, without the direct assistance of any other force, can manage to shear the ice? Or to put the question under another form: heat does not reduce the shearing force of the ice of a glacier to something like 1·3193 lb. per square inch of surface, the unit required by Mr. Moseley to enable a glacier to shear by its weight; the shearing-force of the ice, notwithstanding all the heat received, still remains at about 75 lbs.; how, then, can the glacier shear without any other force than its own weight pushing it forward? This is the fundamental question; and the true answer to it must reveal the mystery of glacier-motion. We are compelled in the present state of the problem to admit that glaciers do descend with a differential motion without any other force than their own weight pushing them forward; and yet the shearing-force of the ice is actually found to be thirty or forty times the maximum that would permit of the glacier shearing by its weight only. The explanation of this apparent paradox will remove all our difficulties in reference to the cause of the descent of glaciers.

There seems to be but one explanation (and it is a very obvious one), viz., that the motion of the glacier is *molecular*. The ice descends molecule by molecule. The ice of a glacier is in the hard crystalline state, but it does not descend in this state. Gravitation is a constantly acting force; if a particle of the ice lose its shearing-force, though but for the moment, it will descend by its weight alone. But a particle of the ice will lose its shearing-force for a moment if the particle loses its crystalline state for the moment. The passage of heat through ice, whether by conduction or by radiation, in all probability is a molecular process; that is, the form of energy termed heat is transmitted from molecule to molecule of the ice. A particle takes the energy from its neighbor A on the one side and hands it over to its neighbor B on the opposite side. But the particle must be in a different state at the moment it is in possession of the energy from what it was before it received it from A, and from what it will be after it has handed it over to B. Before it became possessed of the energy, it was in the crystalline state—it was ice; and after it loses possession of the energy it will be ice; but at the moment that it is in possession of the passing energy is it in the crystalline or icy state? If we assume that it is not, but that in becoming possessed of the energy, it loses its crystalline form and for the moment becomes water, all our difficulties regarding the cause of the motion of glaciers are removed.* We know that the ice of a glacier in the mass cannot become possessed of energy in the form of heat without becoming fluid; may not the same thing hold true of the ice particle?

*The alleged limit to the thickness of a glacier.*—In his memoir, "On the Mechanical Properties of Ice," published in the Philosophical Magazine for January, 1870, Canon Moseley arrives at a conclusion in regard to the crushing of ice to which I am unable, without some qualifications, to agree. In his experiments ice was crushed under a pressure of 308·4 lbs. on the square inch, and he concludes that if a glacier is over 710 feet in thickness the ice at the under surface must be crushed by the incumbent weight. Professor Philips also made some experiments on the crushing of ice, and he came to the conclusion that the height of a crushing column of ice is between 1000 and 1500 feet, and concluded also that if a glacier were to exceed this in thickness the ice would lose its solidity.[*] Whether the height of a crushing column of ice be 710, or 1000, or 1500 feet is of no consequence whatever as regards the possible thickness of a glacier. No doubt a piece of ice solidified not under pressure would be crushed to powder were it placed under a glacier 1000 feet in thickness or so; but after being crushed it would resolidify, and would then probably be able to sustain a pressure of 2000 feet of ice. This follows as a necessary consequence from the property of regelation. There is as yet, so far as I am aware, no known limit to the amount of pressure which ice may sustain. There probably is a limit; but what that limit is has not yet been determined. Canon Mosely says that "there is no glacier alleged to have so great a depth as 710 feet." The Humboldt glacier in North Greenland, according to Dr. Kane, has a depth of more than three times 710 feet. And Dr. Hayes found in Baffin's Bay icebergs (which are just pieces broken off the ends of glaciers) aground in about half a mile of water. And on the antarctic continent we have reasons for believing that the ice is in some places over a mile in thickness.[†]

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* See Phil. Mag. for March 1869, p. 201.

3. *On Eozoon Canadense;* by Prof. Wm. King, S.C.D., and Thos. H. Rowney, Ph.D., of the Queen's Univ. in Ireland, and the Queen's College, Galway. 42 pp. 8vo, with three colored plates, (Proc. R. Irish Acad., July 12, 1869). Professors King and Rowney have here discussed anew the nature of the so-called Eozoon, with many additional observations, and argue for their former conclusion, that the Eozoon is of mineral origin alone. The closing paragraph of the memoir, here cited, gives some idea of their view.

Finally, to subscribe to the organic origin of "*Eozoon*," the *chemist* must become a believer in *quasi*-alchymy, and in *direct* oceanic precipitations unknown in nature. The *mineralogist* must assume certain obscure and insufficiently tested bodies to consist of calcite: he must be inappreciative of the various allomorphs of serpentine, and of pseudomorphic phenomena; and consider every imbedded crystalline body—"tuberculated," or "segmented"—"cylindrically shaped," or with angles rounded off—to be the remains of an organism. The *palæontologist*, besides slighting all he knows of the circumstances of petrifaction, must accept as a "fossil" a production never found in rocks that ought to contain it. Even the *zoologist* must believe to be a "*nummuline* foraminifer" what is structurally an *Impossibilitas Naturæ*, in having a "canal system" and "skeleton" that often "*run wild*" without either "chambers" or a "cell wall"; and in being seldom otherwise than *inconceivably* the result of pseudopodial tubulation.

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[*] Paper on Glacial Striation read before the Geological Section of the British Association, 1865.

[†] Geological Magazine for June, 1870, p. 276.

4. *On Fossil Remains of Mammals found in China*, by Prof. OWEN, (Q. J. Geol. Soc., for Aug., 1870).—Prof. Owen describes in this paper the following species: 1. *Stegodon Sinensis* Ow., from a tooth obtained "from marly beds in the vicinity of Shanghai, probably Tertiary," (belonging to the group of Elephants called "transitional forms" by Owen in his Odontography, which Falconer defined and named Stegodon); 2. *S. orientalis* Ow., said to be "from a cave near the city of Chung-tung-foo, Province of Szochuen," and having a more recent aspect than the tooth of *S. Sinensis*; 3. *Hyæna Sinensis* Ow., from specimens supposed to come from a Chinese cavern; 4. *Rhinoceros Sinensis* Ow., probably from the same cavern; 5. *Tapirus Sinensis* Ow., id.; 6. *Chalicotherium Sinensis* Ow., id. The specimens, excepting that of the *S. Sinensis*, were obtained by Mr. Swinhoe from apothecaries in China; and Prof. Owen observed that out of the great quantity of fossils that had thus come into his hands, he had selected for description those agreeing in chemical and other characters, and which "might justly be inferred to be of the same age, and to be derived from the cave mentioned by Mr. Swinhoe."

5. *Diamonds of South Africa.*—According to Dr. JOHN SHAW. as we learn from *Nature*, Nov. 3, the Vaal region, now famous for its diamonds, contains syenite and other metamorphic rocks, quartzite, micaceous sandstones, and clay schists, with trap or basalt and trap conglomerate. The diamonds are found in alluvial gravel, and this gravel contains pebbles of quartzite, granite, clay-slate, garnet, tourmaline, spinel, agate, iron pyrites, the whole waterworn and polished, and imbedded, at Klipdrift, in a brownish fatty clay. Diamonds have been found two hours distance from Potchefstroom, and all down the Vaal to its junction with the Orange river, and thence to ten hours distance below Hope Town, a range of at least 500 miles. Dr. Shaw is of the opinion that the diamonds have come "from some rock which may now have vanished, but which existed formerly through the whole region." The old diggers prefer for their washings the summits of the Kopjes, where the gravel is of wide extent and is far above the influences of the river. These summits are all basalt. In the hollows no gravel is open to view, it being covered with sand, "the accumulation of present denudation;" and thus far the diggers have not undertaken the labor of carrying off the surface sand for work below. "The present diamond digging of South Africa is therefore only trifling in comparison to what it should and will ultimately be."

6. *Publications of the Geological Survey of India*, *under the direction of* THOMAS OLDHAM, LL.D.—Published by order of His Excellency, the Governor General of India, in Council.—These publications now include six volumes of Memoirs in large octavo; a thick quarto volume with many plates, under the general title Palæontologica Indica, on the Cretaceous Gasteropoda, by F. Stolicka; another, on the Cretaceous Cephalopoda, by H. F. Blanford and F. Stolicka; and parts of two others, on the Fossil Flora of the Rajmahal Hills, Bengal, by T. Oldham and John Morris, and on the Vertebrate Fossils from the Panchet Rocks, Bengal, by

T. H. Huxley; also brief Annual Reports of the Survey; also Catalogues of the Meteorites, and of some departments of Organic remains in the Museum of the Geological Survey of India. The Survey also issues "Records" of the survey, consisting of short papers, in large 8vo, at intervals of about three months. The first number of the second volume (1869) contains 24 closely printed pages. Subscriptions for the year 4 shillings sterling. The address for the publications of the survey is Superintendent of Geological Survey of India, Hastings street, Calcutta. The present year 1870, is the 15th of the survey.

7. *Geological Survey of California*: Ornithology, vol. I. Edited by S. F. BAIRD from the manuscript and notes of J. G. COOPER. 592 pages, royal 8vo, with 6[illegible] cuts. 1870. (Soon to be issued, and sold by Little, Brown & Co., Boston; uncolored, $10).—This admirable report is far in advance of any similar work on Ornithology hitherto published in this country, if not in Europe, and does great honor both to the state of California and the officers of the Geological Survey. The first volume contains descriptions of all the land birds hitherto found in the region north of Mexico and west of the Rocky Mountains. Each genus is illustrated by a reduced full length cut of one of the species, and by natural size cuts of the wing, tail, bill, and foot, which will render it very easy for any one to recognize each genus, while nearly all the species are illustrated by full size cuts of the heads, often of both male and female. The cuts are nearly all original and have been drawn and engraved with great care and skill. The cuts are, in our estimation, superior both in accuracy and beauty to any hitherto published in any work on ornithology, and are far more satisfactory than the highly colored, but often coarse and inaccurate, lithographs, so often employed to illustrate ornithological works. Much information in regard to the habits and geographical distribution of the species has been contributed by Mr. Cooper. One feature, rather novel in general works on ornithology, though in accordance with the views of many modern ornithologists, is a decided change in the systematic arrangement of the orders and families. The singing birds are placed in the first rank, where they doubtless belong, while the rapacious birds take a much inferior position, next to the Rasores, instead of being placed at the head of the whole class, as is usually the case. An edition with colored illustrations is in course of preparation. V.

8. *Geological Chart of Sweden.*—Sheets 3[illegible] to 35 inclusive of the Geological chart of Sweden have recently been issued. Nothing can exceed the beauty and perfection of coloring, or the apparent exactness and fullness of scientific details. As there is no department of art in which this country is more behind hand than that of map coloring, and none of Science so disgraceful to us, as that of Geological Charts, we could wish that a copy of the chart might be in the hands, not only of all Geologists, but also of all members of Congress and State legislatures. The only commendable geological map ever published on this continent is the Canadian, and that was engraved and printed in Paris.

9. *Delesse's Lithologie des Mers.*—Besides the European chart, oticed in a recent volume of this Journal, Delesse has issued one f North America. It is a beautifully colored chart, and illusates the lithology of the bottoms of the seas as far as known to im, together with the hydrographic basins. His chartist has not een as careful as is desirable for such work. He has joined the ead of the Hudson river above Albany to the Chesapeake; while e Hudson River itself he has dwindled to a little stream rising in estern Connecticut. The errors probably crept in through caressness in tracing off from another chart. But there is other ant of exactness, showing that the chart needs careful revision. o text for it has yet been issued.

## III. ASTRONOMY.

1. *On the Mass of Asteroids between Mars and Jupiter;* by rof. DANIEL KIRKWOOD, Bloomington, Indiana.—According to everrier, the total mass of the ring of minor planets does not xceed one-fourth of the earth's mass, or $\frac{1}{1200}$th of that of Jupiter. o great a disproportion between two adjacent planets is without parallel. Is the fact susceptible of a probable explanation?

Were the sun transformed into a gaseous spheroid with an equaorial radius equal to the diameter of the earth's orbit, a large umber of the known asteriods would, in perihelio, plunge into the olar mass and be reunited with it. Now this, in all probability, precisely what occurred soon after the abandonment of the steroid zone, while the solar nebula was in process of condensaon. The powerful mass of Jupiter would produce great eccenicity in parts, at least, of the primitive ring. Large portions of s matter, or a considerable number of minor planets in a state of apor, may thus have been precipitated upon the sun before the tter had contracted within their perihelion distance. The small ass of Mars may perhaps be accounted for on the same hypothsis.—*Proc. Phil. Soc. Philad.*

2. *Astronomical and Meteorological Observations made at the nited States Naval Observatory during the year* 1867; published y authority of the Hon. Secretary of the Navy, Commodore . F. SANDS, Superintendent. Washington, Gov. Printing Office, 870.—The Astronomical observations of the year 1867 at the aval Observatory, together with the computed positions of the bjects observed, fill over 400 closely printed quarto pages in this olume, and the meteorological observations about 50 pages.

To these results of routine work are added four important reorts as appendices.

App. 1. Difference of Longitude between Washington and Ha ana; by Prof. W. Harkness, U. S. N. App. 2. Observations of he total eclipse of the Sun of Aug. 7th, 1869. App. 3. Positions f the Fundamental Stars, deduced from Washington observations ade between the years 1862 and 1867 inclusive; by Prof. S. Newomb, U. S. N. App. 4. Catalogue of 151 stars in Præsepe, by rof. A. Hall, U. S. N.

Prof. Harkness gives for the position of Morro Light, lat. 23°

9′ 21″·0 North, lon. $0^h$ $21^m$ $13^s·43$ West, or 82° 21′ 20″·4 W. of Greenwich. The latest edition of the Admirality list of lights in the West Indies, gives 82° 22′ 12″ for the longitude, nearly a mile in error.

The second appendix has been noticed in this Journal, (II, vol. xlix, p. 134).

We cannot too highly commend in the management of the Naval Observatory, this practice of publishing memoirs prepared by the Assistant Professors *under the name of the authors.* The personal interest in the careful elaboration of the subjects which is thus secured is of great value to science. This practice has been most injuriously and unjustly departed from in more than one observatory in times past.

## IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Solar Eclipse of Dec.* 22, 1870.—Congress having appropriated $29,000 to enable the Superintendent of the Coast Survey to observe the total eclipse of the sun, which will be visible on the shores of the Mediterranean on the 22nd of Dec. next, Professor Peirce has organized two parties, one which, under his own lead, will occupy several points in Sicily, while the other, under the direction of Prof. Joseph Winlock, director of the Harvard observatory, will occupy points near the line of totality in Spain.

Prof. Peirce is accompanied by Messrs. C. A. Schott, J. H. Lane and Chas. S. Peirce of the Coast Survey, Major H. L. Abbott and Capt. O. H. Ernst of the U. S. Engineers, Prof. J. C. Watson of the University of Michigan, Dr. C. H. F. Peters of Hamilton College, Prof. W. Eimbeck of St. Louis, and Messrs. H. G. Fitz and D. C. Chapman of New York, the two latter having been provided with outfit and instructions for photographic observations by Mr. Lewis M. Rutherfurd of New York.

Prof. Winlock's party consists of G. W. Dean, assistant in the Coast Survey, Professors C. A. Young of Dartmouth College, E. P. Pickering of the Mass. Inst. of Technology, S. P. Langley of the Western University of Penn. at Alleghany, Mr. Alvan G. Clark of Cambridge, and Mr. O. H Willard, photographer of Philadelphia, together with four aids.

On the part of the U. S. Naval Observatory four observers have also been sent out, viz: Professors S. Newcomb, A. Hall, W. Harkness and J. R. Eastman. J. E. H.

Four parties have left England under the auspices of the British Government, one to Cadiz in charge of Rev. S. J. Perry; one to Gibraltar under Captain Noble; a third to Oran (Algiers) under Mr. Huggins; and a fourth to Sicily, under Mr. Lockyer. "*Nature*" of Nov. 24 states that "Professors Young, Pickering, Newcomb, Peters, Watson, Harkness, and others are at present in London, and are daily affording most valuable information to the Organizing Committee and the various observers." While the British Government were hesitating with regard to sending expeditions for observations Prof. Peirce extended an invitation to the English astronomers to join his parties.

2. *A Topographical Survey of the Hawaian Islands* has been rdered by the Legislature of the Islands, and an appropriation of 5000 made for procuring instruments and meeting the expenses of le first year. Prof. W. D. Alexander of Oahu has been appoin-ed Surveyor General, and is making arrangements for commenc-ig the work. He proposes to measure a base line on the sandy thmus between East and West Maui, which is six or seven miles ide, and to carry forward the survey as nearly as possible after le methods of the U. S. Coast Survey. Geological and Botanical ollections and observations will be made in connection with the urvey.

3. *A Central Observatory.*—Prof. H. A. Newton has suggested iat an excellent position for the great central observatory of the ontinent is a few miles east of St. Louis, on the 90th meridian om Greenwich. American time reckoned from such an observa-ory would differ from Greenwich time just six hours, and Ameri-an longitudes from standard longitude from Greenwich by ninety egrees. It is believed that there are good locations, as regards tmospheric and other conditions, on that meridian not far from t. Louis.

4. *Telescopes.*—Messrs. Alvan Clark & Sons have received recent-y two orders for telescopes of about 25-inch object glass; one from Ir. McCormick, and the other from the National Government.

5. *Auroral Belt of Oct. 24–25th.*—An account of the remarka-le crimson belt, in the great auroral display of Oct. 24–25th, by rof. A. C. Twining, is deferred to the next number for want ot pace.

## OBITUARY.

**DR. MATTHIESSEN.**—The death of Dr. Augustus Matthiessen ill be learned with sorrow by those of our countrymen who new him in Heidelberg, in the years of his student-life; or who eceived from him afterward in London, the attentions which his indness of heart made him ready to bestow.

Dr. Matthiessen's mind was peculiarly fitted for scientific re-earch. The acuteness which leads to the perception of truth, etects as well the sources of error and suggests the means by hich they may be avoided. With the most persevering industry e had a fondness for experimental enquiry; and as his mind oved easily, he was capable of long continued exertion.

The work which first brought him into notice, was a memoir pon the "Preparation and Properties of the Metals of alkaline arths," made while yet a student in the laboratory at Heidelberg. rof. Bunsen had himself obtained the metals lithium and mag-esium; to them Dr. Matthiessen now added strontium and cal-ium. After his return to London he began an investigation of e conducting powers of the metals and their alloys for electricity, hich occupied him several years, and was afterwards extended to eir conducting powers for heat. He subsequently examined the hemical properties of the alloys of zinc with bismuth and with ad; and an alloy of tin and gold which he had obtained in rystalline form. Upon these subjects he delivered in 1867, a cture before the Chemical Society of London, which was repeated before the Royal Society in the following year. He also investigated the chemical constitution of the opium bases and their products of decomposition, and made elaborate determinations of the expansion by heat of mercury and water. For his various researches the Royal Society, of which he was early chosen a fellow, awarded him in 1869, its gold medal.

In the fifteen years which comprise his scientific life Dr. Matthiessen published at least twenty-eight memoirs. That he was able to accomplish so much was owing in great part to a judicious economy of time, not the penuriousness which refuses hours of relaxation to days of labor, but to a right choice, of subjects which would repay investigation, and of the most direct means by which the investigation could be carried out. He had also the faculty of availing himself of the powers of others by associating them with his work.

With remarkable acuteness of mind, or shrewdness, Dr. Matthiessen had a sincere and affectionate disposition. Resolved from the first to make his own way, he was always ready to help on others. He was a kind, a firm, a generous friend; generous of his thoughts, his means, and his influence. At the time of his death, no man of his age in England stood in a higher position in science; nor was there one from whose future, judging from his past, more might with reason have been expected. D.

Mr. EDWARD HARTLEY, Mining Engineer of the Geological Survey of Canada, died in Pictou, Nova Scotia, on the 10th of November last, aged twenty-three years. Mr. Hartley was the eldest son of Mr. William M. B. Hartley of New York, and grandson of Mr. Philos Blake of New Haven. He early showed a special aptitude for the study of the natural and physical sciences, and for mechanics. At the age of fifteen he became a student in the Sheffield Scientific School of Yale College. On leaving the school, though still very young, he was at once charged with the examination and surveying of mineral lands in Maryland and Pennsylvania, and subsequently with the erection of machinery for working gold in North Carolina. His abilities attracted the attention of the officers of the Geological Survey of Canada under Sir W. E. Logan, and in July, 1868, he joined the Survey as a geological assistant. The following year he was appointed Mining Engineer to the Geological Survey. His duties from this time confined him to the coal-fields of Nova Scotia, where in 1868 he worked conjointly with Sir W. E. Logan, and in 1869, alone, completing a careful and detailed Survey of the Pictou coal-basin, of which an elaborate report by Sir William and another by himself was printed and privately distributed before his death. It will be published with a map in the forthcoming volume of the Geological Survey.

During 1870, Mr. Hartley was engaged with an assistant in the Survey of the Cumberland coal-basin in Nova Scotia, and of the Cape Breton collieries, and had nearly completed his labors for the season when he died after an illness of but six days duration, brought on, probably, by labors beyond his physical strength.

T. S. H.

**Edwin W. Root**, Prof. of Chemistry in Hamilton College, died Nov. 15, in the 30th year of his age. On returning to this country in 1865, after his studies in Germany, he was appointed Assistant Professor of Analytical Chemistry in the School of Mines of Columbia College. Afterward, in 1868, he became Professor of Agricultural Chemistry, and the next year of General Chemistry, in Hamilton College. Prof. Root was highly esteemed for his scientific and literary attainments, integrity of character, and tested ability.

## V. MISCELLANEOUS BIBLIOGRAPHY.

1. *Storer's (Frank H.) Cyclopædia of Quantitative Analysis;* Part I, 112 pp. 8vo, with an appendix of 8 pages. Boston and Cambridge, 1870. Sever, Francis & Co.—Prof. Storer states in his preface that his object in preparing this book has been not only to provide the student and working chemist with a comprehensive dictionary of quantitative processes, but to show also the possibility of presenting this branch of chemical art in a more serviceable and manageable form than has been customary hitherto: and he adds, 'the experiment is certainly worth trying whether a definite system of classifying substances in alphabetical order, and of referring each and every process to the fundamental fact or *principle* upon which it depends, will not greatly facilitate both the study and the practice of Analysis.' An examination of this first part of Prof. Storer's "Cyclopædia" reveals at once the hand of a master as distinguished from the work of the compiler. The alphabetical order by no means hampers the author's philosophical treatment of subjects. This is particularly well illustrated in the articles "CARBON" and "CARBONIC ACID," where the originality of the method of treatment is surpassed only by the thoroughness of the detail given of all methods, of any value, known to chemists, for the determination of carbon whether as such—as in the analysis of cast-iron and steel—or by its oxidation to carbonic acid and estimation in any mixture or compound. The author's entire familiarity with the whole field of chemical literature has enabled him to render a justice to American researches in analytical chemistry which has never been awarded by any foreign author.

2. *The Story of the Rocks. A Fourteen Weeks' Course in Popular Geology;* by J. DORMAN STEELE, A.M., Ph.D., Principal of Elmira Free Academy, author of a Fourteen Weeks' Course in Chemistry, etc. 280 pp. 12mo. 1871. New York and Chicago. (A. S. Barnes & Co.).—This small geological text-book will be read with interest by those that are not critical, and are satisfied with so brief a presentation of the science. While in many respects well arranged for instruction, and clear in its descriptions, its statements are often wanting in exactness, and its explanations unsatisfactory. The following are a few examples. "Rocks are composed in general of only three common minerals, *Quartz*, *Clay* and *Lime*." But clay is not a mineral; lime should be *limestone*; and granite and all the crystalline rocks have no place under such a definition.

Again, "Oolite is a limestone containing [should be, consisting of, although the bad drawing given sustains the author] numerous, small rounded [add concretionary] grains, resembling the roe of a fish." He says that, "The coral animal thrives best in pure water, about a hundred feet in depth," in place of the fact that reef-forming corals thrive well at low-tide level and at all depths below down to one hundred feet, while other coral animals occur at depths exceeding a thousand feet. The author attributes the "continually vibrating to and fro" of the continent, which finally culminated in the folding of the rocks producing the Appalachians, to "the tremendous pressure of the two oceans during the Carboniferous age." Bad hydrostatics, this. A drawing of an Ichthyosaurus represents him spouting like a Right Whale!

3. *A Text Book of Elementary Chemistry, Theoretical and Inorganic;* by GEORGE F. BARKER, M.D., Professor of Physiological Chemistry in Yale College, New Haven, Conn. vi and 342 pp. 12mo. New Haven, 1870. (C. C. Chatfield & Co.)—Prof. Barker has produced a compact Elementary Text Book, the dimensions of which adapt it to the use of schools, and which is the first in our language wherein "Modern Chemistry" is presented systematically. The style of the work is concise and animated, the illustrations are fresh, the typography is good, and it cannot fail of a hearty welcome among our teachers and learners.

4. *The American Naturalist, a popular Illustrated Magazine of Natural History.* (Salem, Mass. $4.00 a year).—This monthly Magazine of Naturalist History has won for itself a high place among the Journals of the world. It knows how to popularize science without degrading it. Many of its articles are by some of the best zoologists of the country, and contain the results of original observation. The illustrations are always excellent.

A Monograph of N. A. Astacidæ. by Dr. Hermann A. Hagen; No. III, of the Illustrated Catalogue of the Museum of Comparative Zoology of Harvard College. (Published by order of the Legislature of Massachusetts). 112 pp. roy. 8vo, with 11 plates. Cambridge, 1870. To be noticed in our next No.

Students' Manual of Comparative Anatomy, and Guide to Dissection, by G. Herbert Morrell, B.A.. B.C.L. Longmans, Green & Co. Aves, ready. Mammalia promised for November.

Elementary Treatise on Natural Philosophy, by Sir W. Thomson and Prof. Tait. In the press. Macmillan & Co.

The Petroleum Monthly, devoted to the interests of the Oil Business. S. P. Irvin and J. H. Bowman. Editors and Publishers, Oil City, Pa. The first number of this Journal appeared on the first of November. Price three dollars a year.

Catalogue of the Principal Minerals of Colorado, with notes. by J. Alden Smith. 16 pp. 8vo. Central City, 1870.

A Monograph of the Alcedinidæ: or, Kingfishers, by R. B. Sharpe, F.L.S., &c., Librarian to the Zoological Society of London, to be complete in fifteen parts. Price to subscribers, 10s. 6d. each. Annual subscription, £2 2s. Only thirty copies now remain of this work. The price will be raised when the work is completed, which will soon be. Intending subscribers are respectfully requested to send their names to the author, at "The Zoological Society of London," 11 Hanover Square, London, W. Also, uniform with the above, A Monograph of the Capitonidæ: or, Scansorial Barbets by C. H. T. Marshall, F.Z.S., and G. F. L. Marshall, F.Z.S. To be completed in nine parts. Price 10*s.* 6*d.* each.

THE

# AMERICAN

# JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

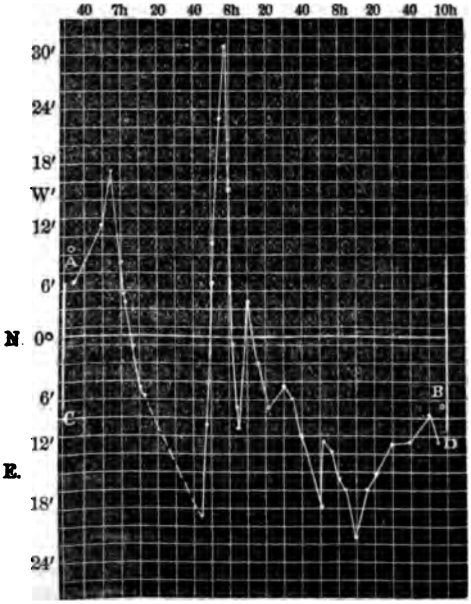
## ART. XII.—*Observations on the Variation of the Magnetic Declination in connection with the Aurora of October* 14, 1870. *With remarks on the physical connection between changes in area of disturbed solar surface and magnetic perturbations;* by ALFRED M. MAYER, Ph.D.

THE aurora of October 14th was first observed by me at $6^h$ $30^m$ P. M. as a ruddy glow in the N.N.E., reaching to about 40° above the horizon. The magnetic observations were commenced at $6^h$ $35^m$. In the following table the first column contains the times of observation in Bethlehem mean time (long. E. Washington $6^m$ $42^s$, lat. N. 40° 36′ 24″), while in the second are given the declinations, + indicating a W. and − an E. movement of the N. end of the magnet in reference to the line of mean declination of the day, taken as the mean of the maximum E. elongation at $8^h$ $30^m$ and the maximum W. elongation at $13^h$ $17^m$. This line of mean declination we will call 0°.

| Time. | Declination. | Remarks. |
|---|---|---|
| $6^h$ $35^m$ | + 5′·70 | An arch of silvery light in the N., whose sagitta appears to be in the magnetic meridian. Clouds on the horizon partly obscure its outline. |
| 6 50 | +11′·46 | Arch about 20° in altitude; definition faint. Streamers W.N.W. and E.N.E. |
| 6 56 | +18′·37 | Aurora the same as at 6 50. |
| 7 00 | + 8′·00 | |
| 7 02 | + 4′·55 | |
| 7 03 | + 3′·39 | |
| 7 6½ | − 1′·20 | |
| 7 9 | − 5′·81 | Arch very faint; no streamers. |
| 7 12 | − 6′·96 to −5′·81 | |
| 7 46 | −21′·94 to −17′·23 | Streamers of crimson hue E.N.E. reaching to 60° in [altitude. |

| Time. | Declination. | Remarks. |
|---|---|---|
| $7^{h}\ 48^{m}$ | −12′·72 to −6′·96 | Crimson and greenish streamers N.W. to N.E. |
| 7 51½ | + 4′·55 to +8′· | |
| 7 52½ | +10′·31 to 11′·46 | Greenish streamers extending about 50° above arch. |
| 7 55½ | +21′·83 to 25′·28 | Aurora nearly the same as at $7^{h}\ 52\frac{1}{2}^{m}$. |
| 7 57½ | +31′·04 to 32′·19 | |
| 8 0½ | +22′·98 to 17′·22 | This easterly motion of the magnet is steady and rapid. At the same time deep rosy streamers flash up in the N.N.W. |
| 8 1¾ | − 1′·20 | Red streamers have disappeared. |
| 8 3½ | − 8′·12 | Aurora the same as at 8 −1¾. |
| 8 5½ | −10′·42 | Aurora same as above. |
| 8 10 | + 2′·24 to 4′·55 | Crimson glow in N.E. |
| 8 16 | − 3′·51 to −2′·36 | |
| 8 21½ | − 9′·27 to −6′·96 | Aurora has declined to a faint white arch. |
| 8 30 | − 5′·81 to −5′·24 | Faint white streamers from the arch. |
| 8 35 | − 6′·96 | Streamers very faint. Arch ill-defined; moon is rising. |
| 8 40 | −12′·72 | |
| 8 50 | −18′·48 | |
| 8 51 | −11′·57 | Aurora still fainter. |
| 8 55 | −13′·30 to 12′·15 | " barely visible. |
| 9 00 | −15′·60 | |
| 9 5 | −17′·91 | |
| 9 10 | −22′·52 | Aurora invisible. |
| 9 16 | −17′·33 | " " |
| 9 20 | −15′·03 | " " |
| 9 30 | −11′·57 | " " |
| 9 40 | −11′·57 | " " |
| 9 50 | − 8′·69 | " " |
| 10 00 | −11′·86 | " " |

These determinations are here expressed graphically. The ordinates above the 0° line indicate a W., and those below, an E. position of the N. end of the magnet referred to the line of mean declination of Oct. 14. The vertical line C shows the average daily range (12′·85) as given by the mean of the range of the five days before and of the five days after the auroral display; not including in the mean the range of Oct. 14. The line D represents the range (18′·43) of Oct. 14. A is the position the magnet had (+9′·33) at $1^{h}\ 17^{m}$ P. M. on Oct. 14, while B is the declination (−7′·25) at $8^{h}$ (the time of greatest E. elongation) on the morning of Oct. 15.



It will be observed, on referring to the column of "Remarks" in connection with the curve, that the motion of the needle coincided in its maxima and minima with the greatest activity of the aurora; and the rapid and steady easterly motion, from $7^h\ 57^m{\cdot}5$ to $8^h\ 5^m{\cdot}5$, of $42'{\cdot}04$, is remarkable. Viewed in the declinometer it appeared exactly as though a distant disturbing body was gradually receding from the magnet. The flashing up of brilliant streamers at the time of the beginning of this easterly motion is also to be noticed.

The magnet used in these observations is a cylindrical bar 8 ins. long 0·4 in. in diameter, attached to a plane mirror 2 ins. square, and suspended by 2 ft. of untwisted silk fibers. The scale is placed 3 meters from the mirror and with the telescope deflections of $10''$ can be read.

It is to be remarked that the auroral observations do not comport in accuracy with the observations of declination. Having no assistance, I could only observe from a N. window directly after having obtained the scale readings, therefore there are many phenomena of this aurora, which appeared in the zenith, and S. of E. and W., which I did not observe.

In connection with the above observation, I will here give an account of a systematic work in which I am engaged and which furnishes a few facts related to the subject of this paper.

Every day about $11^h$ (if clear; if cloudy at the nearest possible time thereto) the mean penumbral diameter,[*] in seconds, of every spot and tache on the sun is measured. These diameters are then reduced to what they would be if viewed normally. Each of these measures is then squared and *their sum* gives a number which will vary with the umbral and penumbral areas. These daily numbers are therefore directly comparable quantities of the areas of solar disturbance; at least so far as that disturbance is evinced in the formation of spots. Similar measures are made on all the faculæ I can manage. Remarks are also recorded as to changes in spots and faculæ. In connection with the above measures the daily range of magnetic declination is determined to $10''$.

The object of this work is to discover, if possible, a more certainly based physical connection between the daily *changes of area* of solar disturbance and the variation of daily range of declination. It seems that if the ten-year cycle of solar spots has a physical connection with the varying mean yearly range of declination, that such a connection can be detected and satisfactorily established—if not in the special cases of ordinary daily variation of declination—at least in the cases of great magnetic disturbances or "storms" either accompanied or not by auroral displays. But, as a spot indicates—if not entirely, at least principally—an effect of an action which has done its work, we must look more minutely to the *changes in area of disturbance*. For, if the connection exist, it will show itself principally *during* the periods of rapid increase or decrease in area of solar disturbance and not when a maximum or minimum area has been reached and remains constant.

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[*] When the greater diameter equals or exceeds twice that of the lesser the spot is divided into two or more measures.

These remarks are illustrated by measures on the penumbral areas made before and after the auroral displays of the 14th Oct. and of Oct. 24 and 25.

The declination range on Oct. 11, three days before the aurora, was 11′·28 and increased with the area of solar disturbance to the 14th when it reached 18′·43 and the area-number on this day equalled 17075; but on Oct. 15th, the day *after* the aurora, the declination range had *fallen* to 11′·52 while the area-number had reached 18875, showing an increase of 1800 from noon of the 14th to noon of the 15th, *during which interval* the aurora broke forth. On the 16th the range was 11′·52 and the area-number 15795.

On Oct. 21, three days before the auroral display of Oct. 24, the declination range was only 3′·94; the area-number 13748. On Oct. 22, decl. =12′·75; area-number =14732. On Oct. 23, decl.=11′·53; area-number =15991. On Oct. 24, the aurora (as I subsequently learned from the newspapers) was observed at Cincinnati and Cleveland at 5 A. M. I observed myself the great disturbance a few minutes before 8 A. M., when I began my magnetic observations for obtaining the max. E. elongation. At 11 A. M. the measure of solar disturbance gave 16954 and the observed declination range on that day equalled 44′·79. On Oct. 25, it reached 54′·63.* On Oct. 26, the declination range equalled 14′·26 and the area-number had declined to 11959. Here also we observe that the aurora appeared during the period of increase in the penumbral surface.

These facts, brought forward as illustrations of my remarks and not as *proof* of the physical connection of disturbed solar area and magnetic perturbation,—for that will require almost constant coincidences,—show at once wherein lies the difficulty of such a research; a difficulty which seems not to have been appreciated by those who have given their energies more to a mathematical than to a physical analysis of the connection of these phenomena; and that is, the frequent impossibility of fixing the *time* at which such a change in area took place. It is very evident, in the first example, that it took place between noon of the 14th and noon of the 15th, but whether it coincided with the auroral display and magnetic perturbation could only have been determined by means of solar measurements, or photographs, taken at several stations differing greatly in longitude. This shows the absolute necessity of several such stations; and that future research in this direction cannot rely alone on the work of the Kew Observatory. Also, the prevalence of cloudy weather in England, especially during the fall and winter months, will add force to the above opinion.

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* On the 24th the disturbance was greatest between 9 and 10 A. M. On Oct. 25, the greatest perturbations were from 12 M. to 2–56 P. M. During the evening displays of this aurora the needle was only slightly deflected. 113 observations were made by me on this aurora.

Rapid changes in spot-area are well known to all students of the solar surface. A good example occurred in the largest spot in the S.W. quadrant of the sun during the time of the memorable eclipse of Aug. 7, 1869. Measurements on two photographs, taken at intervals of about two hours gave a closing up of the umbra of 2360 miles in a N.E. and S.W. direction. (See my report on the eclipse in Oct. No. of the Jour. of the Franklin Inst.). The astronomer Wallaston says:—"Once I saw, with a 12-inch reflector, a spot burst in pieces while I was looking at it. I could not expect such an event, and therefore cannot be certain of the exact particulars; but the appearance, as it struck me at the time, was like that of a piece of ice when dashed on a frozen pond, which breaks in pieces, and slides on the surface in various directions. I was then a very young astronomer, but I think I may be sure of the fact."

Carrington, Hodgson and Brodie have observed brilliant clouds appear in the neighborhood of spots, and progress with a velocity of over 6,000 miles per minute; while Prof. C. A. Young has recently made a most remarkable spectroscopic observation of two such brilliant clouds—together over 130,000 miles in breadth—which in ten minutes had contracted their dimensions to an enormous extent; this however, judging from analogy, was probably due to vertical motion.

The question now naturally presents itself:—In case this physical connection between the disturbed solar area and the terrestrial magnetic condition exist, in what does it consist? What is the nature of this connection? Is it owing to an inductive action of the sun? if so, the magnetic intensity of a body depending greatly upon the condition of its surface, that inductive action will vary with the character of its surface. If this be the case then we should take into consideration the probable condition of the hidden solar hemisphere, deduced from preceding observations on it where it was visible combined with subsequent ones when it again appeared. But can we apply such reasoning to a body covered with tumultuous gases heated to an enormous temperature? Does not the connection consist in the action of the solar vibrations sent forth from the chief source of all energy? The experiments of Morrichini, Mrs. Somerville, Zantedeschi and others were once viewed as conclusively showing effects produced by these vibrations sufficient, not only to increase the magnetic intensity of natural and artificial magnets, but also to give magnetism to steel needles previously devoid of that property; but the more recent experiments of Riess and Moser[*] cast such doubt over preceding results that the subject has since received but little attention. It is also to be remarked that Faraday, when in Rome with Sir H. Davy in May, 1814, spent several hours at the house of Morrichini, working with his apparatus and under his directions, but could not succeed in magnetizing a needle. Morrichini attributed the failure to the misty state of the atmosphere.

With our present imperfect knowledge of the various forms of energy existing in the solar emanation these questions cannot be answered; but the fact that they can be asked, and the fundamental cosmical relations which will be revealed by their solution, is sufficient to induce men of sicence again to attack this problem,—though its solution baffled all the manipulative ingenuity and philosophical acumen of a Faraday[†]—the correlation of the solar emanations and electricity and magnetism.

## Art. XIII.—*Notes on Granitic Rocks;* by T. Sterry Hunt, LL.D., F.R.S. First Part.[‡]

(Read before the American Association for the Advancement of Science at Troy, August 20, 1870.)

Contents of Sections.—§ 1–2, Definitions of granite and syenite; § 3, Structure of granitic and gneissic rocks; § 4–5, Felsites and felsite-porphyries; § 6, Gneisses and granites of New England; § 7, Granitic dykes and granitic veinstones; § 8, Scheerer's theory of granitic veins; § 9–10, Elie de Beaumont on granites and granitic emanations; § 11, Granitic distinguished from concretionary veins; § 12, Von Cotta on granitic veins; § 13–14, The author's views on the concretionary origin of granitic veins; § 15, The banded structure of granitic veins.

§ 1. The name of granite is employed to designate a supposed eruptive or exotic unstratified composite rock, granular, crystalline in texture, and consisting essentially of orthoclase-feldspar and quartz, with an admixture of mica, and frequently of a triclinic feldspar, either oligoclase or albite. This is the definition of granite given by most writers on lithology, and applies to a great portion of what are commonly called granitic rocks; there are, however, crystalline granite-like aggregates in which the mica is replaced by a dark colored hornblende or amphibole, and to such a compound rock many authors have given the name of syenite, while to those in which mica and hornblende co-exist, the name of syenitic granite is applied. It is observed that in certain of these hornblendic granites, the quartz becomes less in amount than in ordinary granites, and finally disappears altogether, giving rise to a rock composed of orthoclase and hornblende only. To this binary aggregate von Cotta and Zirkel would restrict the term syenite, which was already defined by d'Omalius d'Halloy to be a crystalline aggregate of hornblende and feldspar, by which orthoclase-feldspar may be understood, since he describes varieties of syenite as passing into diorite, a name by most modern lithologists restricted to a compound of albite or some more basic triclinic feldspar with hornblende. It is apparently by failing to appreciate the distinction between orthoclase and triclinic feldspar in this connection, that Haughton has lately described under the name of syenite rocks composed of crystalline labradorite and hornblende.

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[*] Ann· de Chem. et de Phys., t. xlii, p. 304.

[†] See Life and Letters of Faraday, vol. ii, pp. 301 *et seq.* and p. 351.

[‡] This, with the following part, embraces the matter of the paper read at Troy in August last. It is proposed in the third and fourth parts to describe the Laurentian veins and to consider the subject of eruptive granites.

§ 2. Naumann, regarding orthoclase and quartz as the essential constituents of granite, designates those aggregates which contain mica as mica-granites, and thus distinguishes them from hornblende-granites, in which the mica is replaced by hornblende. These definitions seem the more desirable as the name of granite is popularly applied both to the hornblendic and the micaceous aggregates of orthoclase and quartz. There are not wanting examples of well-defined rocks of this kind in which both mica and hornblende are almost or altogether wanting. Such rocks have been designated binary granites, a term which it will be well to retain. Chloritic and talcose granites, into the composition of which chlorite and talc enter, need only be mentioned in this connection. The name of syenite, so often given to hornblendic granites, will, in accordance with the views already expressed, be restricted to rocks destitute of quartz. While the disappearance of this mineral from hornblendic granites is held to give rise to a true syenite, the same process with micaceous granites affords a quartzless rock, consisting of orthoclase and mica, for which we have no name. Great masses of an eruptive rock, granite-like in structure, and consisting of crystalline orthoclase or sanidin, without any quartz, occur in the province of Quebec. This rock contains in some cases a small admixture of black mica, and in others an equally small proportion of black hornblende. The latter variety might be described as syenite, but for the former we have no distinctive name, and I have described both of these by the name of granitoid trachytes, a term which I adopted the more willingly on account of the peculiar composition of the feldspar, and also because compact and finely granular rocks in the same region, having a similar chemical composition, present all the characters of typical trachytes, and apparently graduate into the granitoid rocks just noticed.* In all attempts to define and classify compound rocks, it should be borne in mind that they are not definite lithological species, but admixtures of two or more mineralogical species, and can only be arbitrarily defined and limited.

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* This Journal, II, xxxviii, 95. See also Zirkel, *Petrographie*, ii, 179.

§ 3. Having thus defined the mineral composition of granitic rocks, we proceed to notice their structure. Gneiss has the same mineral elements as granite, but is distinguished by the more or less stratified and parallel arrangement of its constituents, and lithologists are aware that in certain varieties of gneiss, this structure is scarcely evident except on a large scale; so that the distinction between gneiss and granite rests rather on geognostical than on lithological grounds. To the lithologist, in fact, the granitoid gneisses are simply more or less stratiform granites, while it belongs to the geologist to consider whether this structure has resulted from a sedimentary deposition, or from the flowing of a semi-fluid heterogeneous mass giving rise to a stratiform arrangement.

§ 4. The rocks having the mineralogical composition of granites present a gradual passage from the coarse structure of ordinary micaceous, hornblendic and binary granites to finely granular and even impalpable mixtures of the constituent minerals, constituting the rocks known as felsite, eurite and petrosilex. These rocks are often porphyritic from the presence of crystals of orthoclase, and sometimes of crystals or grains of quartz imbedded in the finely granular or impalpable paste. These felsites and felsite-porphyries are, in very many cases at least, stratified or indigenous rocks, and they are sometimes found associated with granular aggregates of different degrees of coarseness, which show a transition from true felsites into granitic gneisses. The resemblances in ultimate composition between felsites, granites and granitic gneisses are so close that it cannot be doubted that their differences are only structural.

§ 5. Felsites and felsite-porphyries are well known in eastern Massachusetts at Lynn, Saugus, Marblehead and Newburyport, and may be traced from Machias and Eastport in Maine, along the southern coast of New Brunswick to the head of the Bay of Fundy, with great uniformity of type, though in every place subject to considerable variations from a compact jasper-like rock to more or less coarsely granular varieties, all of which are often porphyritic from feldspar crystals, and sometimes include grains or crystals of quartz. The colors of these rocks are generally some shade of red, varying from flesh-red to purple; pale yellow, gray, greenish and even black varieties are however occasionally met with. These rocks are throughout this region distinctly stratified, and are closely associated with dioritic, chloritic and epidotic strata. They apparently belong, like these, to the great Huronian system.

§ 6. Many of the so-called granites of New England are true
ieisses, as for example, those quarried in Augusta, Hallowell,
unswick and many other places in Maine, which are indigen-
is rocks interstratified with the micaceous and hornblendic
hists of the great White Mountain series. To this class also,
dging from lithological characters, belong the so-called granites
Concord and Fitzwilliam, New Hampshire. These indigen-
is rocks are tenderer, less coherent, and generally finer grained
an the eruptive granites, of which we have examples in the
icaceous granite of Biddeford, Maine, and the hornblendic
anites of Marblehead and Stoneham, Mass., and Newport,
hode Island; in all of which localities the contact of the erup-
re mass with the enclosing rock is plainly seen; as is also the
se farther eastward, on the St. Croix and St. John Rivers in
ew Brunswick, and in the Cobequid Hills and elsewhere in
ova Scotia. The hornblendic granites of Gloucester, Salem
d Quincy, Massachusetts, seem also, from their lithological
aracters, to belong to the class of exotic or true eruptive
anites.[*] The farther discussion of the nature and origin of
ese gneisses and granites is reserved for another occasion, and
now proceed to notice the history of granitic veins.

§ 7. The eruptive granitic masses just noticed, not only in-
ide fragments of the adjacent rocks, especially near the line
contact, but very often send off dykes or veins into the sur-
unding strata. The relation of these with the parent mass is
wever generally obvious, and it may be seen that they do not
ffer from it except in being often finer grained. These injected
intruded veins are not to be confounded with a third class of
anitic aggregates, which I have elsewhere described as granitic
instones, or, to express their supposed mode of formation, en-
genous granites. They are to the gneisses and mica-schists,
which they are generally enclosed, what calcite veins are to
atified limestones; and although long known, and objects of
terest from their mineral contents, have generally been con-
unded with intrusive granites.

§ 8. Scheerer, in his famous essay on granitic rocks, which
peared in the Bulletin of the Geological Society of France in
47, (vol. iv, p. 468), conceives the congealing granitic mass
have been impregnated with "a juice," which was nothing
e than a highly heated aqueous solution of certain mineral
atters. This, under great pressure, oozed out, penetrating even
e stratified rocks in contact with the granite, filling cavities
d fissures in the latter, and depositing therein crystals of
artz and of hornblende, the arrangement of which shows
em to have been of successive growth. Neither Scheerer,

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[*] T. S. Hunt on the Geology of Eastern New England, this Journal for July,
70, p. 88; also Notes on the Geology of the vicinity of Boston, Proc. Boston Nat.
st. Soc., Oct. 19, 1870.

nor Virlet d'Aout, who supported his views, however (*ibid.*, iv, p. 493) extended them to feldspathic veins, though Daubrée, at an earlier date, had described certain granitic veins in Scandinavia as having been formed by secretion rather than by igneous injection, as maintained by Durocher.

§ 9. Elie de Beaumont, starting from the hypothesis of a cooling liquid globe, imagined "a bath of molten matter on the surface of which the first granites crystallized." From the ruins of these were formed the first sedimentary deposits, but directly beneath were other granitic masses, which became fixed immediately afterward. "Some parts of these masses, coagulated from the commencement of the cooling process, but not completely solidified, were then erupted through the sedimentary deposits" just mentioned. "In these jets of pasty matter" were contained many of the rarer elements of the granitic magma, which were thus concentrated in the outermost portions of the granitic crust, and in the ramifications formed by these portions in the masses through which they were forced by the eruptive agents. Those portions of the granitic masses, and their ramifications, in which these rarer elements are concentrated, are distinguished from the rest of the masses alike by their exterior position and their peculiar structure. They are often coarse-grained and include the pegmatites, tourmaline-granites, and veins carrying cassiterite and columbite, often abounding in quartz. These mineral products are to be regarded as emanations from the granite, and are described as a *granitic aura*, constituting what Humboldt has called the penumbra of the granite. (*Bull. Soc. Geol. de France*, (2) iv, 1249. See particularly pages 1295, 1321 and 1323).

§ 10. While Fournet, Durocher and Rivière conceived the granitic magma to have been purely anhydrous, and in a state of simple igneous fusion, Elie de Beaumont maintained with Poulett-Scrope and Scheerer that water had in all cases intervened, and that a few hundredths of water might at low red heat have given rise to the condition of imperfect liquidity which he imagined for the material of the injected granites. The coarsely crystalline granitic veins were according to him veins of injection, and he speaks of them as examples in which "the phenomena essential to the formation of granite had been manifested with the greatest intensity." The granitic manations, which are supposed to have furnished the material f these veins, appear to be regarded by him as the result of a rocess of eliquation from the congealing granitic mass. De eaumont is careful to distinguish between them and those manations which are dissolved in mineral waters or are exhaled as volcanic vapors, (page 1324). To the agency of such waters [illegible] ascribes the formation of concretionary veins, which are gene- [illegible] characterized by their symmetrically banded structure.

e further adds that granites, as to their mode of formation, er a character intermediate between ordinary veins and vol- nic and basic rocks. This is conceivable as regards granitic ins, since these, according to him, although formed by injec- n, and not by concretion, result from a process of emanation m the parent granitic mass, which may be described as a nd of segregation.

I have thus endeavored to give, for the most part in his rn words, the views on the origin of granites enunciated by e great French geologist in his classic essay on Volcanic d Metalliferous Emanations, published in 1847. They be- ng to the history of our subject, and are remarkable as a ear and complete expression of those modified plutonic views hich are probably held by a great number of enlightened ologists at the present time. My reason for dissenting from em, and the theories which I offer in their stead will be shown the sequel.

§ 11. Elie de Beaumont, while regarding the formation of anitic veins as a process in which water intervened to give uidity to the magma, was careful to distinguish the process m that of the production of concretionary veins from aqueous lution, and supposed the fissures to have been filled by the jection of a jet of pasty matter, derived from a consolidating anitic mass. Daubrée and Scheerer in describing the granitic ins of Scandinavia, conceive the material filling them to have en derived from the enclosing crystalline strata instead of an stratified granitic nucleus, but do not, so far as I am aware, mpare their formation to that of concretionary veins. Their blications on this subject, it should be said, are both anterior the essay of de Beaumont.

§ 12. The notion that all granitic veins are the result of me process of injection, and not to be confounded with con- etionary veins, seems indeed to have been general up to the esent time. Even von Cotta, while strongly maintaining e aqueous and concretionary origin of metalliferous veins in neral, when describing those consisting of quartz, mica, ldspar, tourmaline, garnet and apatite, with cassiterite, wol- am, etc., which occur at Zinnwald and at Johanngeorgenstadt, at a loss whether to regard these veins, from their granitic aracter, as igneous-fluid injections or as concretionary lodes. support of the latter view he refers to their more or less gular and symmetrically banded structure, and while recall- g the fact that mica and feldspar may both be formed in the mid way, considers the nature of these veins to be very prob- matical, and the question of their origin a difficult one.—(*Ore posits*, Prime's translation, 1870, pages 110–124).

§ 13. I have for several years taught that granitic veins of e kind just referred to are concretionary and of aqueous origin.

In 1863 I described certain veins in the crystalline schists of the Appalachian region of Canada, "where flesh-red orthoclase occurs so intermingled with chlorite and white quartz as to show the contemporaneous formation of the three species. The orthoclase generally predominates, often reposing upon or surrounded by chlorite; at other times it is imbedded in quartz, which covers the latter. Drusy cavities are also lined with small crystals of the feldspar, and have been subsequently filled with cleavable bitter-spar, sometimes associated with specular iron, rutile and sulphuretted copper ores." A study of these veins shows a transition from those "containing quartz and bitter-spar with a little chlorite or talc, through others in which feldspar gradually predominates, until we arrive at veins made up of orthoclase and quartz, sometimes including mica, and having the characters of a coarse granite: the occasional presence of sulphurets of copper and specular iron characterizing all of them alike. It is probable that these, and indeed a great proportion of quartzo-feldspathic veins are of aqueous origin, and have been deposited from solutions in fissures of the strata, precisely like metalliferous lodes. This remark applies especially to those granitic veins which include minerals containing the rarer elements. Among these are boron, phosphorus, fluorine, lithium, rubidium, glucinum, zirconium, cæsium, tin and columbium, which characterize the mineral species apatite, tourmaline, lepidolite, spodumene, beryl, zircon, allanite, cassiterite, columbite, and many others."—(*Geology of Canada*, p. 476, also p. 644.)

In this connection I referred to the occurrence of orthoclase with quartz, calcite, zeolites, epidote and native copper in certain mineral veins of Lake Superior, so well described by Prof. J. D. Whitney, (this Journal, II, xxviii, 16). The associations, according to him, show the contemporaneous crystallization of the copper, natrolite, calcite and feldspar, which last was found by analysis to be a pure potash-orthoclase.

§ 14. In 1864, this view was still farther insisted upon in this Journal, (II, xxxvii, 252), where, in speaking of mineral veinstones "which doubtless have been deposited from aqueous solution," it is added, "while their peculiar arrangement, with the predominance of quartz and non-silicated species generally serves to distinguish the contents of these veins from those of injected plutonic rocks, there are not wanting cases in which the predominance of feldspar and mica gives rise to aggregates which have a certain resemblance to dykes of intrusive granite. From these, however, true veins are generally distinguished by the presence of minerals containing boron, fluorine, phosphorus, cæsium, rubidium, lithium, glucinum, zirconium, tin, columbium, etc.; elements which are rare, or found only in minute quantities in the great mass of sediments, but are here accumulated by deposition from waters, which have removed these ents from the sedimentary rocks and deposited them sub- ently in fissures."

the Report of the Geological Survey of Canada for 1865 92), I have, in describing the veins of the Laurentian , insisted still farther on the distinction just drawn be- n granitic dykes and granitic veinstones, which latter I proposed to call endogenous rocks to indicate the mode of formation, and to distinguish them from intrusive or exotic , and sedimentary or indigenous rocks.

.5. The peculiar banded arrangement which is so charac- ic in concretionary veins not granitic in composition is ably not less marked in granitic veinstones, and often ars in these in a remarkable manner, showing that they have formed by successive depositions of mineral matter, and rally in open fissures. This structure, and various peculiari- o be observed in granitic veinstones, will be best illustrated escriptions of various localities, most of which I have per- lly examined. It is proposed to notice first, the veins of neiss and mica-schist series of New England, and secondly of the Laurentian rocks of New York and Canada. In atter class will be noticed the more or less calcareous vein- s into which the Laurentian granitic veins are found to uate.

[To be continued.]

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## T. XIV.—*On Siredon Metamorphoses, etc.*; by E. D. Cope.

E late observations by various writers on the metamor- es of Amblystoma, especially those of Mr. Tegetmeier, ate that some of the principal facts in the history of the ect have been overlooked by all of them.

the first place, no one has seen any metamorphosis of Siredon, *Siredon Mexicanus* Shaw (*S. pisciformis*, *S. axolotl* *S. maculatus* Auctorum) which inhabits the lakes of Mexico, of which the Smithsonian collections contain numerous imens. Whether it undergoes a metamorphosis is entirely nown to naturalists, though I would express the belief that ill be found to do so occasionally, under suitable circum- ces. No Amblystomæ have been brought from Mexico h of Tamaulipas and Chihuahua, by any of the various ralists collecting for the Smithsonian Institution.

the next place, Prof. Baird was aware of the metamor- es of all the North American species of Siredons many s before the observation of it in the Jardin des Plantes, ough at first he named one of them *Siredon lichenoides* treat- it as a mature animal. He regarded these creatures as larvæ is essay on the North American Salamanders, published in ladelphia in 1847.

Thirdly, the important observation of Duméril[*] established the fact that the Siredons reproduced as such, and his account, of the subsequent loss of larval characters by the offspring, is the first of a positive character which we possess on that point.

After this, in 1867,[†] the writer recorded the various stages of metamorphosis in different structures, to be observed in reproducing individuals of two species of *Amblystoma*, viz: *A. tigrinum* and *A. mavortium*. These embraced various Siredon characters of the dental, branchial, and dermal organs, and of coloration. It was suggested that the metamorphoses observed by Duméril were those of *A. mavortium*, which was confirmed by an examination of specimens sent to the writer by Prof. Duméril,[‡] a year afterward. At the same time the periods of metamorphosis of eight other species of the genus were stated, and the Mexican *axolotl* was regarded as an *Amblystoma*, whether undergoing metamorphosis or not, owing to the irregularity of its occurrence in the most nearly allied species, *A. mavortium*, or from its Siredon stage, *S. lichenoides* Baird.

In 1868 Prof. Marsh of Yale College observed the metamorphosis of the *A. mavortium*, confirming the conclusions of previous writers. Since that time the changes have been observed by Dr. Tegetmeier and others.

The only point remaining to be determined, is whether *Siredons* (i. e. *Amblystoma Mexicanum*) undergo a metamorphosis or not. Among our numerous specimens I can find none that exhibit any tendency toward the change.

I might add here that I have had for a time in a winter fernery, a large New Jersey specimen of *Amblystoma tigrinum*, a foot in length. It is nocturnal in its habits, and remains during the day in its burrow. This extends through the long diameter of its prison, and has three outlets, which it keeps open. From one of them, as evening approaches, it projects its head, and watches with attention what is transpiring in the room.

In the same case are specimens of the common *Plethodon cinereus* of both varieties. During this, as in former years, I observe that this species is nocturnal, and is a great climber. They will climb the rachis of a most slender fern, or spear of grass, and lie in a coil on the end of a tall frond or other narrow support, which may be sufficient to bear their weight, at a height of a foot or eighteen inches above the ground. They climb a plate of glass with great ease, by adhering closely to its smooth surface with their moist abdomen. When disturbed on some high perch among the herbage, they leap away by a sudden unbending of the coiled body, in the manner of some caterpillars.

[*] Bulletin Société d'Acclimatation, 1865, II, 348.
[†] Proceedings Acad. Nat. Sciences, Philad., 166.
[‡] Origin of Genera, 1868, p. 47.

## ART. XV.—*Lower Carboniferous Limestone in Ohio;* by Prof. E. B. ANDREWS.

FOR several years I have suspected that a certain limestone n southeastern Ohio should be classed with those of the Lower Carboniferous limestones. The supposition was entirely contrary to the "traditions of the elders," and furthermore, the imestone was *above* the principal range of conglomerate which has been ever regarded as true Coal-measure conglomerate. In the prosecution of the Ohio Geological Survey, in the 2d district, entrusted to me, I find that the conglomerate referred to s a Waverly conglomerate; that it is separated from the base of the productive Coal-measures by an upper Waverly sandstone group, rich in fossils, which I have called the *Logan sandstone group*, and that resting upon this group is, in many places, a limestone, called the *Maxville limestone*, which is a true Lower Carboniferous limestone. This limestone is not a continuous deposit but has only a local development here and there, always resting, however, upon the fine-grained Logan sandstone group. It was deposited in quiet basins along a uniform horizon. Generally, there is an iron ore adhering to the top of the limestone. There is no evidence that the local deposits were once continuous and united and were subsequently separated by erosion. The stratigraphical position of the limestone and the contained fossils led me to suspect that we had in it an Ohio representative of the Chester limestone of the Illinois Reports. This opinion has been confirmed. Prof. F. B. Meek, now engaged in the study of our Ohio fossils, has sent me the following report in regard to the fossils of the Maxville limestone:—

"*List of species and genera.*

1. *Zaphrentis.* A small undetermined curved conical species.
2. *Scaphiocrinus decadactylus* Hall? Described from the Chester group.
3. *Productus pileiformis* McChesney. Described from the Chester group. Thought by Mr. Davidson to be the same as *P. cora* d'Orbigny.
4. *Productus elegans* N. and P. Described from the Chester group. Some of the specimens may be the form Prof. McChesney described from the same horizon under the name *P. fasciculatus.*
5. *Chonetes.* Undetermined species.
6. *Athyris subquadrata* Hall. Described from the Chester (Kaskaskia) group.
7. *Athyris trinuclea* Hall. sp. Described from the St Louis (Warsaw) group.
8. *Spirifer* (*Martinia*) *contractus* M. and W. Described from the Chester group.
9. *Spirifer.* Undetermined fragments of perhaps two species.
10. *Terebratula.* An undetermined, small oval species showing the fine punctures under a lens.
11. *Aviculopecten.* Undetermined species.
12. *Allorisma.* Undetermined fragments, apparently like *A. antiqua* Swallow, described from the Chester group.
13. *Naticopsis.* A small undetermined species.
14. *Straparollus perspectivus* Swallow, sp. Probably a more elevated form of *S. planidorsatus* M. and W. Both were described from the Chester group.

15. *Bellerophon sublaevis* Hall. Described from the St. Louis (Warsaw) limestone.
16. *Pleurotomaria.* A small undetermined cast.
17. *Nautilus.* A small undetermined compressed, discoidal species with the very narrow periphery truncated.
18. *Nautilus.* A large sub-discoid undetermined species, with an open umbilicus and only slightly embracing volutions that are somewhat wider transversely than dorso-ventrally, and provided with a row of obscure nodes around near the middle of each side. Very nearly allied to *N. spectabilis* M. and W. from the Chester group, but more compressed and having narrower and apparently one or two more volutions. Specimens mere fragments."

In his letter Prof. Meek adds: "From these fossils, it is clearly evident that the limestone, from which they were obtained, belongs, as you had supposed, to the horizon of the Lower Carboniferous limestone series of the Western States. They also show that it does not belong to any of the inferior members of that series.

Of the 18 or 20 species of fossils sent from this rock, about one half are represented in the collection only by specimens that are too imperfect for specific identification; though none of them, so far as their characters can be made out, appear to be allied to known forms from any horizon below the St. Louis limestone.

Of the remaining species, five can be identified confidently with Chester forms, and three others are either identical with Chester species, or most closely allied to forms of that age. Hence we may safely say that eight of the species are *Chester types.* Two, however, seem to be identical with species described from the St. Louis limestone farther west.

From these facts I can scarcely doubt that we have in these local masses of limestone a representation of the Chester group of the Lower Carboniferous limestone series; though it is possible that there may also be some representation of the St. Louis limestone of the same series at some of the outcrops. * * *

The discovery of these beds is, I believe, the first indication we have had of the existence of any member of the Lower Carboniferous *limestone* series of the West in Ohio. They also seem to show that the old Carboniferous sea did not extend to this region during the deposition of any but the later members of the lower limestone series, although we know it had done so previously, that is, during the older Waverly period."

The largest and best development of the Maxville limestone is in Muskingum county, in the vicinity of Newtonville, where it is from 15 to 20 feet thick. Although here within the geographical limits of the productive coal-measures, it is well exposed in the deep valleys of Jonathan's creek and other tributaries of the Moxahala creek. It is also found in Perry, Hocking, Vinton, Jackson and Scioto counties.

A single analysis of the stone showed it to be a double carbonate of lime and magnesia.

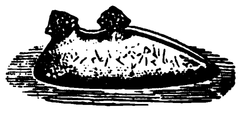
## ART. XVI.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XI. *Descriptions of some imperfectly known and new Ascidians from New England;* by A. E. VERRILL.

(Continued from page 56.)

### *Cynthia stellifera* Verrill, sp. nov. Figures 5, 6.

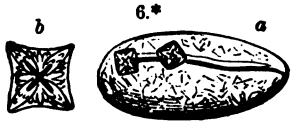
Body depressed, oval or elliptical, attached by a broad, expanded base, with thin edges. Integument firm, thick, and opaque, the surface uneven with irregular, imperfectly reticulated wrinkles, between which the surface is somewhat raised, producing an irregularly tessellated appearance, most conspicuous above; the raised parts are minutely granulous. A somewhat elevated, rounded ridge passes from the lowest end over the top and between the tubes, connecting them together. The tubes are quadrangular, low, truncate, nearly equal, a little divergent, situated toward the larger end, a little to one side, and separated by a space greater than their diameters; both have similar apertures, cross-shaped in partial expansion, and surrounded by four larger papillose lobes, between which there are many smaller ones (fig. 6, *b*).

5.



Color of the body, when living, reddish brown, ferruginous, or purplish brown, often yellowish toward the margin, the median ridge yellowish brown; apertures sometimes bright orange within, in the area immediately around the openings purplish, with minute, radiating streaks of flake-white; the four large lobes are brownish, with numerous small specks and streaks of flake-white, which often predominate over the ground-color.

6.*



The largest specimens are about an inch in length, and half an inch in breadth.

At New Haven Light and Savin Rock, near the entrance of New Haven Harbor, adhering to the under side of stones at low-water mark,—A. E. Verrill.

### *Cynthia monoceros.*

*Ascidia monoceros* Möller, Index Mollusc. Groenlandiæ in Kroyer's Naturhist. Tidsskrift, iv, p. 95, 1842.

*Cynthia condylomata* Packard, Invert. of Lab., in Mem. Boston Soc. Nat. Hist., i, p. 277, 1867; Binney, op. cit., p. 19, Pl. xxiii, fig. 324, 1870.

An examination of Dr. Packard's original specimens shows that they are identical with Möller's species. It differs widely from all others from the American coast in the elevated tubercles of the surface and the prominent, conical summit, between the tubes.

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* Figure 6.—*Cynthia stellifera* V.; *a*, view from above, natural size; *b*, view of one of the tubes from above, enlarged about three diameters.

According to Möller the color is pale red, with red orifices.

It is an Arctic species, not yet observed south of Labrador, and the Banks of Newfoundland. From the latter locality I have seen many fine specimens, collected by T. M. Coffin and J. P. Haskell, some of them 3 inches high and ·75 in diameter.

### *Cynthia carnea* Verrill. Figures 7, 8, 9.

*Ascidia carnea* Agassiz, Proc. American Assoc. for Adv. Sci., ii, p. 159, 1850, (description insufficient); Binney in Gould's Invertebrata of Mass., 2nd ed., p. 25, Pl. xxiv, figures 334, 335, 1870, (young).

? *Cynthia gutta* Stimpson, Proc. Boston Soc. Nat. Hist., iv, p. 231, 1852, (young); Binney, op. cit., p. 19, 1870.

*Cynthia placenta* (*pars*) Packard, Mem. Boston Soc. Nat. Hist., i. p. 277, 1867; Binney, op. cit., p. 19, Pl. xxiii, figure 322, 1870; Verrill, Amer. Journ. Sci., xlix, p. 424, 1870.

When adult, this species is often two or three inches high and about an inch broad at the base, which is broadly adherent and thin at the margin.

The body is elongated, subconical, cylindrical, or urn-shaped and swollen above the middle (fig. 7), according to the state of expansion, and very changeable in form. The integument is rough, thick, firm, opaque, and reticulated with deep wrinkles, which are very conspicuous in contraction, but less numerous at the base, the interstices are raised and thickly covered with small granules. The tubes are terminal, subequal, divergent, enlarged at the bases, moderately elongated, tapering to the tips, with small square apertures. The anal tube is generally the most bent, and a little the longest. In contraction the body is low, conical, or hemispherical, with the surface coarse and rough, conspicuously reticulated and granulated; the tubes form low, four-lobed verrucæ, covered with rough granulous papillæ; the apertures are cross-shaped.

The color, when living and expanded, is dark reddish brown, or orange-brown, darker below, the wrinkles lighter than the interstices and often salmon-colored; the upper parts, especially the summit between the apertures, are deep salmon. The apertures are orange-red or salmon-color within, and surrounded by a ring of bright red. The ovaries were filled with deep red eggs and embryos, and discharged the active tadpole-shaped larvæ early in September.

7.

When younger the form is quite different (fig. 8), and when contracted corresponds in part with Packard's *C. placenta.*[*] In expansion, however, the central portion of the body rises up and becomes prominent, subconical, rounded at the summit, and terminated by two prominent, nearly equal tubes, which are large at the base and taper rapidly to the square apertures. The base is broadly expanded, with a thin extended margin, and adheres very closely, so that it is often impossible to detach it without rupturing the integument. The ovaries are filled with bright red eggs and embryos, nearly the color of blood. The surface is wrinkled and reticulated nearly as in the adult, except that it is not so rough; the margin of the base is nearly smooth.

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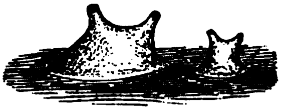
[*] By an examination of Dr. Packard's specimens I find that one of them belongs to a quite distinct species, having the surface minutely papillose and covered with closely adhering grains of sand.

8.

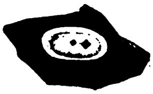


The color is similar to that of the adult, though usually lighter; the wrinkles are generally salmon-color and the raised interstices dull reddish brown; the upper part between the tubes lighter, often salmon-color; the apertures bright red or orange inside.

When quite young (fig. 9) the body is very low and adheres by a broad base, which is very thin at the edge and expands in the form of a whitish margin around the slightly raised central part, which is oval or elliptical, and rounded above, in expansion, with the two small apertures on slightly raised tubes, one a little larger than the other. In contraction the body is nearly flat, the apertures sessile. In this state the integument is smooth at and near the margin, and only slightly roughened or indistinctly reticulated in the central parts. At a little earlier stage of growth it is entirely smooth.

The color is bright light red, deep pink-color, or blood-red, the raised interstices, when apparent, are deeper red; a bright pink or red line usually connects the two apertures, which are bright red; the thin margin of the base is whitish or light flesh-color, and transparent. The ovaries are filled, as in the older ones, with blood-red eggs and embryos. In this stage of growth it corresponds perfectly with *A. carnea* Agassiz, as figured by Binney, and probably with *A. gutta* Stimpson, though the latter may possibly be the similar young of some other species.

9.



Eastport Harbor, at extreme low-water of spring tides, under stones, rare; in 10 to 50 fathoms, on dead shells, stones, large ascidians, and *Modiola modiolus*, more common, but not abundant,—Expeditions of 1863, '64, '68, '70; South Bay, Lubec, 10 to 15 fathoms, shelly, not rare,—Exp. 1868, '70; off East Quoddy Light, young on smooth stones in 80 fathoms, abundant,—Exp. 1868; Off Head Harbor, Campo Bello I., in 100 to 120 fathoms, shelly,—Exp. 1870; Grand Menan, 15 to 20 fathoms, shelly.—Exp. 1870: Labrador, 10 to 40 fathoms.—Packard; Massachusetts Bay.—L. Agassiz, W. Stimpson.

On the European coasts there are species that have similar young, which have also received in several cases specific names. Among these *C. grossularia* Van Ben., *C. limacina* Forbes and Hanley, and the young of *C. rustica* as figured in the Zoologica Danica (Tab. xvi), may be mentioned, but I am not aware of any European species corresponding to the adult state of this. *C. rustica* seems, from the figures, to be the nearest allied species, but has a contracted base, is more cylindrical or subglobular, the upper portion is more decidedly tuberculose, the apertures are farther apart and less prominent, the inner tunic is light red, yellowish below, and it is represented as attached to seaweeds by root-like processes from the base. The young are similar to those of *C. carnea*, but show no marginal expansion. The original *rustica* of Linné was an arctic species and perhaps identical with this. I adopt the name, *carnea*, in preference to the others, because it is more applicable, although when first given it was not accompanied by a recognizable description.

### *Cynthia echinata.*

**Ascidia echinata** Linn. Syst. Nat. ed. xii, p. 1087, 1767. (**non** Forbes and Hanley).*

**Ascidia echinata** Fabr. Fauna Groenl. p. 331, 1780; Rathke, Zoologica Danica, iv, p. 11, Pl. cxxx, fig. 1, 1806; Möller, Index Mollusc. Groenl., in Kroyer's Nat. Tidsskrift, iv, p. 95.

**Cynthia echinata** Stimpson, Invert. of Grand Manan, p. 20, 1854; Binney, op. cit. p. 18, Pl. xxiii, fig. 315.

Body subglobular, attached by a small basal disk. Integument firm, opaque, more or less wrinkled, the interstices enclosed by the wrinkles raised and lighter colored, the whole surface covered with velvet-like, fine, soft fibers; with numerous scattered elevated tubercles, each bearing a stellate cluster of 6 to 9 radiating, yellowish bristles or flexible spines. The tubes are wide apart, terminal, small, subequal, a little elevated, both with small square apertures.

The color of the body, when freed from the foreign matters which are entangled and held firmly by the spines and fibers, is usually deep salmon, often more or less tinged with pink or flesh-color, and sometimes of a delicate flesh-color throughout. The apertures are red, often bright red with a lighter red ring; the tubes frequently have eight alternate light and deep red longitudinal stripes extending from the edge to the base of the tubes, or four light stripes extending from the angles of the apertures down their sides.

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* Two or more species have apparently been confounded under the name of **echinata**, owing to the peculiar stellate bristles with which they are covered. The **Ascidia echinata** of Forbes and Hanley, Brit. Mollusca, i, p. 33, Pl. C, fig. 4), if correctly figured, is a true Ascidia, very different from the present species, but covered with similar though more distant stellate bristles. It may be called, with propriety, *A. Forbesii*. The species described by Linnæus came from Iceland and is probably the same as that here described.

The largest specimens observed are rather more than an inch in diameter; the tubes about ·10 of an inch high, and about the same in diameter at base; the apertures about ·05.

Eastport and Grand Menan at low-water under stones; and in 10 to 120 fathoms, not uncommon, attached to other ascidians, dead shells, stones, etc.,—Expeditions of 1859, '63, '64, '58, '60; Labrador,—Packard; Greenland,—Fabricius, Lütken; Norway, —Rathke; Iceland,—Linné; Grand Banks,—T. M. Coffin.

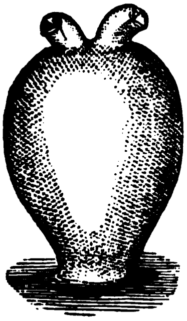
### *Cynthia pyriformis.* Figure 10. "Sea Peach."

*Ascidia pyriformis* Rathke, Zoöl. Danica, iv, p. 41, Tab. clvi, figs. 1, 2; Möller, op. cit., Kroyer's Tidss., iv, p. 95, 1842.

*Cynthia pyriformis* Stimpson, Invert. Grand Menan, p. 20, 1853; Packard, op. cit., p. 277; Binney, op. cit., p. 17, Pl. xxiii, figs. 320, 321, 1870.

Form quite changeable, in expansion most frequently somewhat pear shaped or urn shaped, largest at or above the middle and somewhat smaller below; or subcylindrical and considerably elongated, with the top rounded; often in partial contraction subglobular, attached by a narrow base. When young the form is commonly nearly spherical, with a more or less narrowed basal attachment, and sometimes so constricted toward the base as to be slightly pedunculated. In large specimens there are usually more or less numerous, short, irregular, mostly lobed and divided rootlets, which originate close to the base. Tubes subcylindrical, large and prominent, terminal, near together at base, but divergent; the branchial one is largest and curves outward more or less abruptly; the anal is considerably smaller and swollen in the middle.

10.



Whole surface of the test minutely roughened or velvety, like the skin of a peach; it is covered with very small rounded granules or verrucæ, each of which bears a short flexible bristle or hair-like process; these, under the microscope, are found to give off minute sharp branches, directed forward, and irregularly placed; considerably larger bristles, of the same kind surround the apertures. In quite young specimens these bristles are larger and more conspicuous, being readily visible to the naked eye, and the apertures appear ciliated with the larger ones.

Color generally yellowish white, more or less tinged on the upper part and one side with peach-red; frequently yellowish white throughout, or merely tinged with orange in certain parts, especially between the tubes. Not unfrequently the color is deep orange-red or peach-red over most of the surface, except the lower part of the sides, which are flesh-color or salmon-color, and a band of light orange bordered with darker orange-red, which passes from each tube down the sides to the base; a similar band or spot generally exists between the bases of the tubes. The apertures are salmon-color inside, often surrounded by a delicate circle of red, or in the darker specimens with a pale orange circle.

The larger specimens from Eastport are often 3 inches high in expansion, and 1 to 1·25 in diameter; diameter of the branchial orifice ·25; of anal ·15 of an inch. From the Banks of New Foundland I have seen specimens 3 inches in diameter.

Massachusetts Bay.—A. E. Verrill: Eastport and Grand Manan, from near extreme low-water mark of spring tides, under and among stones, to 50 fathoms, shelly and stony, common.—Expeditions of 1859, '63, '64, '68, '70; Off Head Harbor, 80 to 120 fathoms, gravelly and shelly bottoms, common,—Exp. 1870: Grand Menan,—Stimpson: Str. Belle Isle, Labrador, —Packard; Banks of New Foundland,—C. Foster, T. M. Coffin; Greenland,—Möller, Lütken: Norway,—Rathke, Sars.

### *Cynthia pulchella*, sp. nov.

Body subglobular, attached by a small base. Test firm, opaque, smoothish, covered with minute, flatish, slightly raised, scarcely granular elevations, visible with a lens. Tubes slightly raised, terminal, not very near together: apertures small, square, nearly equal.

Color, in alcohol, purplish or grayish white, the apertures deeper purple. The specimens were not observed while living, and were probably similar in color to *C. pyriformis*, with which they were mixed.

Diameter ·12 to ·15 of an inch, probably young.

Eastport 10 to 20 fathoms, shelly.—Exp. of 1870.

The absence of rounded verrucæ and bristles on the test will readily distinguish this species from the last, which it otherwise most resembles.

### *Ascidia complanata* Fabr. Figure 11.

*Ascidia complanata* O. Fabricius, Fauna Groenlandica, p. 332, 1780: Gmelin, Syst. Nat.

? *Ascidia orbicularis* Müller, Zool. Danica, ii, p. 53. Tab. 79, figs. 1, 2, 1788

*Ascidia callosa* Stimpson, Proc. Boston Soc. Nat. Hist., iv, p. 228, 1852; Invert. Grand Manan, p. 19, 1853: Binney, op. cit., p. 26, pl. xxiii, fig. 318, 1870.

Test thick but translucent, oval or elliptical, depressed, adhering by the whole surface of the flattened left side: upper side slightly convex. In young specimens less than an inch long, the form is usually quite regular and the surface smoothish, with slight irregular wrinkles, more numerous around the tubes; in larger specimens the wrinkles become deeper, more numerous, and the surface correspondingly irregular and uneven,

11.

while the test becomes very thick and fleshy and covered with adhering worm tubes, bryozoa, hydroids, etc., and sometimes contains imbedded *Modiolariæ*. The tubes are both on the upper surface, low, sulcated, well separated, slightly divergent. The branchial tube is largest and near one end, a little to one side of the middle, often curved slightly forward, the sides with eight strong sulcations, the intervening ridges rough and often verrucose in large specimens; aperture with seven or eight lobes; each of the angles with a minute orange-red eye-spot. Anal tube smaller, low, subcylindrical, situated farther to one side, and about a third of the length from the anterior end, externally with six ribs and sulcations; aperture six-lobed, each of the angles with a minute orange eye-spot.

Color of the younger specimens pale, translucent, greenish or yellowish gray, or light horn-color, the mantle and dark intestine distinctly visible through the test; large specimens are darker greenish or olive-color, generally becoming more or less rusty brown or russet. Mantle finely speckled with raised yellowish points.

Some of the larger specimens are 4 or 5 inches long and 3 broad; ordinary ones 2 to 3 inches long, by 1 to 1·50 broad, and about ·50 high; height of tubes ·15 to ·25 of an inch; diameter ·15 to ·20.

Eastport, Me., and Grand Menan, at low-water mark under stones, in pools between tides, and at all depths to 120 fathoms, on stony bottoms, very abundant,—Expeditions of 1859, '61, '63, '64, '68, '70; Massachusetts Bay,—A. E. Verrill; Mt. Desert, Me., common,—A. E. Verrill; Labrador,—A. S. Packard; Greenland,—Fabricius, Möller; Grand Banks,—T. M. Coffin.

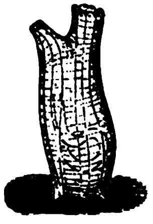
The younger specimens of this species appear to correspond perfectly with *A. complanata* of Fabricius.

*Ciona tenella* Verrill. Figures 12, 13.

*Ascidia tenella* Stimpson. Proc. Bost. Soc. Nat. Hist., iv, p. 228, 1853; Inv. of Grand Manan, p. 20, 1853; Binney, op. cit., p. 24, 1870.

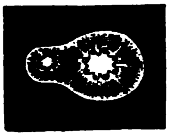
? *Ascidia ocellata* Ag., Proc. Amer. Assoc. for Adv. Sci., ii, p. 159, 1850 (description insufficient); Binney, op. cit., p. 24, pl. xxiv, fig. 332, 1870.

12.



Body elongated, attached by the base, soft, flaccid, varying much in shape in different states of expansion. Tubes subcylindrical, terminal, approximate, a little elongated, the anal smaller and usually divergent, in some states longer, but in other cases shorter than the branchial. Test thin, smooth, transparent; mantle with conspicuous white longitudinal lines and fine transverse ones, the intestine and branchial sac showing through distinctly. At the base the test is often prolonged into short, root-like processes for attachment. Branchial orifice with eight rounded lobes and eight light orange eye-spots; from the angles between the eyes eight conspicuous white lines pass down the sides. Anal orifice with six small lobes and six conspicuous eye-spots, like those of the branchial orifice.

13.



Color transparent whitish, with flake-white lines; mantle transparent, with whitish dendritic markings, not spotted, pale yellowish, deeper above.

The larger specimens are 3 inches long and ·75 in diameter, in expansion; more frequently the height is about 1·50, and the diameter about ·35 of an inch.

Eastport, and South Bay, Lubec, from low-water mark among stones, to 50 fathoms, stony and shelly bottoms, common,—Exp. of 1863, '64, '68, '70; off Head Harbor, 100 to 120 fathoms,—Exp. of 1868, '70; Grand Menan,—Stimpson, and Exp. of 1870; New Bedford, Mass.,—L. Agassiz.

This species is allied to *C. intestinalis* of Europe, and perhaps even more so to *C. fascicularis* Hancock, from Ireland.

ERRATA.—In the last number of this Journal, page 54, line 5, for ***Molgula Manhattensis*** Dekay, read ***Ascidia Manhattensis*** Dekay.

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## ART. XVII.—*On Insects inhabiting Salt Water.* No. 2. By A. S. PACKARD, Jr., M.D.

IN March, 1869, the writer published an article on this subject in the Proceedings of the Essex Institute, Salem, vol. vi, p. 41. Since then I have received an interesting collection of insects from Clear Lake, Lake Co., California, made by Prof. John Torrey, in 1865, and which he kindly placed in my hands for examination. Prof. A. E. Verrill has also allowed me to examine several puparia of Ephydra from Great Salt Lake, and during the past summer has dredged at the great depth of 20 fathoms at Eastport, Maine, a living Chironomus larva, undistinguishable from *C. oceanicus* Pack., found by me in great abundance at low-water mark in Salem harbor; and also a species of marine mite.

With the hope of awakening an interest among biologists in the subject of brine-inhabiting insects, and of receiving farther collections, especially from the salt lakes and salt works of this country, the following notes are published.

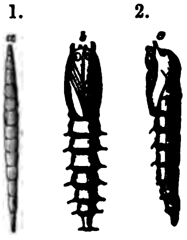
### COLLECTION FROM CLEAR LAKE.

In the collection made in Clear Lake by Prof. Torrey, besides the halophilous larvæ and pupæ of Tanypus and Ephydra, were a number of bees, ichneumons, ants, and a species of Culex, the latter very abundant in the male sex, with several Muscids and Tipulæ; also a species of Chrysopa, and two species of

Coleoptera,* one a Stenus, and the other *Diabrotica soror* Lec., all of which were probably drowned from having accidentally fallen into the lake. In the collection, however, two truly aquatic beetles occurred, one, *Laccophilus decipiens* Lec., a Dytiscidan insect, and the other, *Berosus punctatissimus* Lec., a member of the family Hydrophilidæ. These probably lived in the brine not only in the adult, but also in the larval state.

*Salda interstitialis* Say, also occurred, and two other aquatic hemiptera: a new species of Hygrotrechus and Corixa, which are described by Mr. Uhler farther on.

*Tanypus*, sp.—The larvæ and pupæ of a species of Tanypus (or closely allied genus or subgenus), were abundant at Clear Lake. The body of the larva is long, slender, cylindrical, gradually tapering toward each end. The head is long and narrow, half as long as wide, and one half as long as the prothoracic segment. There are no rudiments of antennæ or maxillary palpi to be seen. In this respect it agrees with a species observed in fresh water at Salem, Mass. The mandibles are long and slender, with the ends very slender, acute, simple, untoothed, and well curved, forming two minute hooks capable of being extended a considerable distance in front of the head. The labium is broad and rounded in front, untoothed; it is situated a little in advance of the middle of the head, and is supported on a pair of slender chitinous pieces, not very approximate, with the outer ends opposite the posterior ocelli. The labrum is broad and rounded, overhanging the mouth. There are two pairs of ocelli situated a little behind the middle of the head; the anterior pair are the smaller and touch the hinder pair. A few hairs are scattered over the head. There are no prothoracic or anal feet, and no anal bristles, or appendages of any kind, not even the few long hairs observed in the Salem species. It is white and ·30 of an inch in length. Fig. 1, larva; 2, front and side view of the pupa.



Enlarged.

The pupa is rather slender, with the abdomen slightly flattened, and rather broad, being nearly as wide as the thorax. The wings and ends of the third pair of feet reach to the posterior edge of the second abdominal segment. The antennæ are laid in between the wings and the second pair of feet, disappearing under the middle of the front edge of the wing. The third pair of feet are concealed by the wings, the tips of the tarsi only being in sight; they are even with the end of the wings. The second pair of feet are entirely concealed, their tips not appearing, while the first pair are entirely in sight, their tips reaching nearly as far as those of the third pair. On the

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* The Coleoptera were obligingly determined by Dr. Horn.

vertex is a pair of minute, acute spines, probably locomotive. From just above the base of the head, and in front of the insertion of the wings arises a pair of meso-thoracic respiratory tubes, which are broad and flat at their base, suddenly becoming cylindrical and slender a little beyond their middle, and projecting slightly beyond the head. The mesothorax is tergally full and rounded. The abdominal segments are very convex, with the sutures deeply marked, the edges of the segments being bevelled in toward the suture. The hinder edge of each ring is raised into an acute ridge, armed with a few short hairs. The terminal segment is slender, no wider than long, and with a small acute, terminal spine on each side. No respiratory appendages. It is whitish, with a yellowish tinge, and is ·15 of an inch in length. No adult Tanapus occurred in the collection.

*Stratiomys*, sp. (Fig. 3 *a*, top view; *b*, side view).—With the young of Tanypus were associated several larvæ of this genus. They are long and slender, the body tapering alike toward both ends. The head is chitinous, sub-conical, and nearly as long as the prothoracic segment. On each side of the base of the head is a deep, slightly curved sinus (closed anteriorly in older specimens), thus forming a rather long tongue-like lobe to the under side of the head. Above, the head is divided by two deeply impressed lines into three lobes extending nearly to the posterior third of the head; these lobes are acutely pointed, the middle one being the longest, and embracing the clypeo-labral region. On the side of the outer lobes and at the middle of their length are situated the two ocelli. The antennæ are minute, acute tubercles situated at the ends of the outer lobes. The maxillæ (?) are two 2-jointed palpus-like appendages, with long hairs at the extremity, and play with much freedom up and down on the under side of the head, between the inner and outer lobes. Mandibles not distinguishable. The mouth parts are all inserted beyond the middle of the head. The body is rather flattened and broadest just in front of the middle; the segments are quite convex, with the sutures well marked. A pair of well marked stigmata on the prothoracic ring; none behind. The body is horn colored, paler beneath, with the integument densely punctured; the upper surface of the body is marbled with alternate light and dark streaks, in the middle of the body fading out in the middle of each segment, but toward the end of the body disappearing toward the sutures. On the side of each segment are four rows of minute dark dots, the upper row passing over the back at nearly

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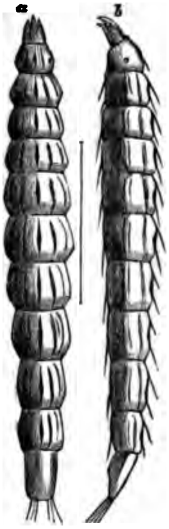

les, meeting the one opposite on the median line of

The anal segment is broad and flat, square at the little rounded at the corners; it is nearly as long as ›st width of the body. From a transverse terminal een from above) projects a group of about ten radiaratory filaments, white and finely ciliated to the tip, ›nts being each a little over half as long as the anal

A little within the middle of this segment is a rather with thickened chitinous edges. A few hairs of vary- ı are scattered over the body. Length ·80 of an inch. › far as I am aware, the first instance of the occur- ;his genus in salt water.

'a *Californica*, n. sp. (Fig. 4; *a*, ventral, *c*, lateral view of the several specimens of the larvæ cies occurred, though the pupæ nore numerous. Unfortunately ıe adults were found, but as the re abundant and the flies could reared from them, I venture to species.

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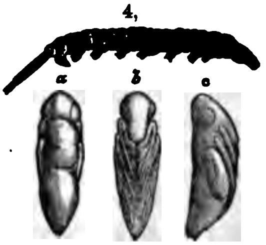

:va closely agrees with that of the European *E. ripa*- ı, described by Loew, but has one more pair of abdomor tubercles. The body is white, long and slender, ıl, the sides of the segments bulging out, and each ıl ring has three transverse, broad, flat tergal ridges; cic segments being smooth above. The anterior end ody, including the thoracic rings, tapers gradually, conical and truncated abruptly. The three thoracic are smooth, but minutely hairy on the anterior edge, being similarly arranged on the abdominal segments. is very small; the mandibles exist in the form of rved, chitinous hooks, with a pair of papilliform antenhind; and a pair of shorter tubercles (rudimentary ı front of them and just behind the mandibles.* The e of the body and base of the respiratory tubes are vith very minute fine stiff hairs, and there is a row of the front edge of the prothoracic rings. On the front on the sternal side of the mesothoracic ring is a dark ,† transversely oblong area, with four clear pale dots, in a transverse row, the space in front being broken hitinous spots; in other specimens this band is much and less distinct. The integument on the tergal side

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›arts need to be studied in the living insect. They are not clearly deholic specimens. I cannot discover the spigot-like stigmata on the ›scribed by Loew.

erm "chitinous" is meant any honey-yellow portion of the integument, r the deposition of chitine. This term may be used to designate this r color, instead of the very vague word testaceous.

of the body is a little thickened and chitinous. There are eight (Loew mentions only seven in *E. salinaria*) pairs of large abdominal fleshy non-articulated legs, like the abdominal fleshy legs of lepidopterous larvæ, ending in two curvilinear rows of well curved dark brown hooks, 5 or 6 in a row; on the terminal pair of feet are four rows, those of the fourth row being minute. The respiratory tube arises suddenly from the end of the terminal segment, stretching straight out posteriorly. The main portion of the tube is rather thick, and about as long as the body is thick. It is of the same thickness throughout; the terminal branches are about one-half as long as the main portion; they also arise suddenly like the joints of a telescope, not by the subdivision of the stalk, but by the sudden prolongation of the tracheæ with their surrounding membranes, and end in a minute nipple-like conical tip, separated by a deep suture from the end of the tube. These respiratory tubes vary in length in alcoholic specimens, as they are undoubtedly more or less retractile. Length including tube, ·50 inch; length of tube, ·15 inch.

The puparium differs from that of *E. halophila* Pack., from the Illinois salt-works, in being about a third larger, and in having a large, rounded tubercle on the side of the 9th and 10th segments, and sometimes a third situated higher up on the 9th ring. The seventh pair of feet are as large as the 6th, being large and quite long, while in *E. halophila*, they are scarcely larger than the five basal pairs. While in *E. halophila* the respiratory tube is not half as long as the body, in the present species it is fully half as long. As in that species they are attached to stalks of grass by curving the anal feet around them. Length ·55 inch; length of tube ·21 inch.

The pupa is white, naked, with the vertex of the head high between the eyes. The mouth parts form a broad, flattened, thick mass, pressed to the breast and reaching the anterior coxæ. Legs folded along the abdomen, the tarsi of the first pair reaching to the distal end of the posterior coxæ; the wings reach half way between the tarsi of the first and second pair of legs; the third pair do not quite reach to the end of the abdomen. At a later stage, when the integument is more chitinous, long hairs clothe the body; the mouth parts can be distinguished, and the legs are longer, the anterior tarsi reaching to the end of the wings, and the third pair of tarsi nearly to the end of the abdomen. All the appendages are enclosed in the pupal membrane of the earlier stage. The tarsal claws are now large and of mature form, while the wing veins can be readily traced. Length, ·25 inch.

Prof. A. E. Verrill has kindly loaned me specimens of the Ephydra, from Mono Lake, Cal., "a body of water not only excessively salt, but also strongly alkaline." These belong, so far as the puparia indicate, to the above species. The puparium of *E. Californica* differs from that of *E. halophila*, in being about a third larger, and in having a large rounded tubercle on the side of the 9th and 10th segments of the body; while the seventh pair of feet are as large as the sixth, being in *E. halophila* scarcely larger than the five basal pairs. The respiratory tube is not half as long as the body in *E. halophila.* The Mono Lake specimens are ·55 inch long, and the respiratory tube ·21 inch.

*Ephydra gracilis*, n. sp.—These insects occur so abundantly where they are found, and can be so easily reared, that I venture to name another form from Great Salt Lake, specimens of the puparia of which have been communicated by Prof. Verrill, from the collection of Mr. Sereno Watson; and by S. A. Briggs, Esq., of Chicago. It is much smaller and slenderer than any of the preceding species, the smaller specimens being ·25 inch long, the largest ·50 inch. The respiratory tube is much longer than in any other species known to me, being in several specimens as long as the body itself; the branches into which it subdivides being over one-third as long as the base of the tube. The body is of the shape of *E. halophila*, but is much slenderer, while the feet are larger and more prominent.

Three specimens of heteropterous Hemiptera, from Clear Lake, were submitted to Mr. P. R. Uhler, who has kindly given me the following description of them.

*Salda interstitialis* Say. Jour. Acad. Philad., iv, p. 324.

A single ♀ specimen, from Clear Lake, California. If the specimen was taken out of the water, it had occurred there by accident. These insects do not live in the water; but affect the marshy ground sometimes adjacent to it. The specimen is immature, lacking the black color proper to the hemelytra and wings; but having the clavus, except at its tip, the base of the corium, and two or three streaks thereon black. The nervures of the membrane are simply brown.

*Hygrotrechus robustus*, n. sp.

One female of this genus (belonging to the family Hydrometridæ) very much mutilated, alone serves us for the present notice. In form it resembles *H. remigis* Say, but the abdomen is more uniformly robust towards the tip. The head is dark brown, fuscous on the middle, sericeous pubescent on the sides and beneath, with a pale arc on the impression at the base of the vertex. Antennæ robust, brownish-ochreous, the second joint just one-half as long as the basal one, the remaining ones destroyed. Rostrum brown, extending a very little way behind the anterior coxæ. Eyes pale brown, large. Thorax robust, pale brownish-testaceous, beneath brownish-ochreous, sericeous; the anterior lobe of pronotum blackish, divided in the middle by an ochre-yellow line, each side between the eyes adjacent to them is an abruptly elevated, rufous tubercle; the mesial carinate line feeble, becoming obliterated posteriorly; humeri elongate-tuberculate, quite prominent; pleuræ darker than the pectus. Legs robust, brownish-ochreous. Hemelytra milky-white, as long as the abdomen, the nervures brownish-ochreous. Tergum pale ochreous, brown at base, the sutures and lateral raised edge brown; connexivum with a silvery, depressed dot adjoining each suture, the apical processes robust, of medium length, hardly acute. Venter smooth, dark ochreous.

Length to tip of processes 17 millims. Breadth across humeri 3 millims.

*Corixa decolor*, n. sp.[*]

Pale testaceous, dirty amber yellow above. Form of *C. hieroglyphica* Fieber, of Europe. Head large, cranium very convex, prominent, carinate on the middle, the vertex acutely produced. Face very deeply, concavely excavated, the cavity broad oval, occupying the whole width between the eyes and extending from near the upper edge of the eyes to the base of the clypeus, the middle of the excavation densely clothed with silvery hairs. Pronotum narrower than the head, almost twice as broad as long, the middle line feebly carinated anteriorly; the surface minutely rastrated, with about eight transverse, slender brown lines, each bounded in front by a faintly impressed line, the anterior line interrupted, the posterior one following the margin of the pronotum; the posterior margin triangularly rounding, extending pretty far back. Pleural pieces whitish; sternum honey-yellow. Anterior legs short, wide, pale honey-yellow, their tibiæ broad, compressed, blade-like on the anterior margin, oblong-oval, but little longer than the palæ; palæ subtriangular, a little longer than broad, fringed with long white ciliæ; the basal angles prominent, feebly rounded, the inner edge a little concave, tip acute. Intermediate and posterior legs slender, paler than the anterior ones, ciliæ and pubescence

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[*] The fact that bread is made by the Mexicans from the eggs of a brine-inhabiting Corixa is noticed in Westwood's "Classification of Insects." Prof. O. C. Marsh has informed me that these brine insects are also noticed by M. Virlet d'Aoust in the Bulletin de la Société Geologique de France, 1858, xv, p. 200, and also by E. B. Tylor in his "Anahuac," London. 1861. The latter says "A favorite dish here [Tezcuco] consists of flies' eggs (*Corixa femorata* and *Notonecta unifasciata*, according to Menneville and Vielet d'Aoust) fried. These eggs are deposited at the edge of the lake, and the Indians fish them out, and sell them in the market place. So large is the quantity of these eggs that at a spot where a little stream deposits carbonate of lime, a peculiar kind of travertine is forming which consists of masses of them imbedded in the calcareous deposit."

The flies which produce these eggs are called by the Mexicans "Axayacatl" or water face. The eggs are sold in cakes in the market, pounded and cooked, and also in lumps *au naturel*, forming a substance like the roe of a fish. This is known by the characteristic name of "*ahua-uhtli*," that is, "water wheat."

In this connection we may remark that, according to the late Mr. Horace Mann, Jr., the Indians about Mono Lake eat large quantities of the puparia of *Ephydra*.

whitish. Hemelytra pale yellowish, the costal area whitish, the cross-nervule and a spot at tip brown; clavus at base with short, narrow brown lines running transversely from the outer and inner margins, beyond the middle to tip the lines run completely across; lines of the corium transverse, slender, slightly waved, many of the intermediate ones entire; membrane pale brown, with short, vermiculate, white lines. Venter and metasternum faintly dusky, the connexivum and genital segments whitish.

Length 4¼ millims. Breadth across the pronotum 1½ millims. This species must be closely related to *C. Burmeisterii* Fieber, of Europe. The shape of the palæ and markings of the hemelytra of our species do not agree with Fieber's description. The specimen described is a male, which appears not to be fully mature. From Clear Lake.

### MARINE INSECTS FROM DEEP WATER.

During his explorations at Eastport the past summer, Prof. Verrill dredged at the depth of 20 fathoms in Eastport harbor a larva of *Chironomus oceanicus* Pack. (Proc. Essex Inst., vol. vi, p. 42). It does not differ from specimens found by me at low-water mark in Salem harbor. It is evidently the same as the supposed larva of *Micralymma?*, mentioned and rudely figured in the American Naturalist, vol. ii, p. 278, found by me many years ago at low-water mark in Casco Bay. It is of the same size as the Salem specimens, being ·25 inch in length.

*Thalassarachna Verrillii* n. sp. (Fig. 5; *a*, head and mandibles and maxillary palpi; *c*, under side; *d*, anterior claw.—This species differs in important particulars from our best known species, *Hydrachna formosa* Dana and Whelpley (Amer. Journ. Sci., xxx, 354, 1836), found near New Haven, in fresh water Unionidæ. The body of that species is much longer, the

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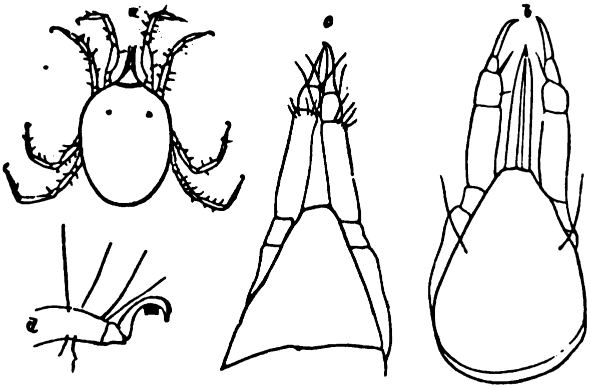

maxillary palpi are stouter and the relative length of the joints very different; the claws are very different, the forks of each claw being large and of equal size, and there is no brush on the base of the claw. At first I was disposed to place this halophilous species in the same genus as Dana and Whelpley's *Hydrachna formosa* and *H. pyriformis*, but having since then, through the kindness of Prof. Verrill, had the opportunity of studying a fresh-water mite closely allied to *H. formosa*, which is described below,* I am led to consider the salt-water mite as the type of a new genus, *Thalassarachna*, with the following differential generic characters; a conical head distinct from the rest of the body, maxillary palpi 5-jointed, each ending in an incurved spine, (the 5th joint). Mandibles large, forming an ensiform beak nearly as long as the palpi. Claws long, the upper hook minute, a single row of hairs on the under side of the lower hook, forming a brush. Otherwise closely allied to Hydrachna.

The body is globular, convex above, with the abdomen obtusely rounded behind; the skin being minutely lineated. It is blackish when alive, with the head and edge of the body white. The head is minute, conical, subacutely pointed in front. The maxillary palpi are 5-jointed, a little more than twice as long as the head, and about one-fourth as long as the fore legs. The second joint short; the third joint one-third as long as the entire palpus; the fourth as long as it is thick; the fifth minute and carrying a long, slender, slightly incurved spine bifid at the tip, the outer fork projecting considerably beyond the inner one. The mandibles form an ensiform acute beak, reaching to the middle of the terminal palpal spine. The two eyes are remote black dots situated on the anterior fourth of the body, over the insertion of the second pair of legs and just in front of them is a well marked transverse groove crossing the body. The legs are 6-jointed, much alike in structure, moderately hairy. The claws are alike in size, the hook being moderately curved, rather ong, bifid at the end, the upper fork being much the smaller, specially on the anterior pairs, forming a small acute tubercle; n the middle of the under side of the claw (on all the feet) is brush of fine hairs of equal length, arranged in a single row. On the penultimate joint of the anterior tarsi are five stout hairs; on the other tarsi three, the two proximal hairs being contiguous. External female genitalia with two bivalve contiguous plates, like those of *H. formosa* Dana and Whelpley. Length ·07 of an inch. The body of the young is whitish, longer, more ovate than in the adult; the abdomen being a little pointed behind.

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* *Hydrachna tricolor*, n. sp. Under this name I describe a beautiful mite, brought me from New Haven by Prof. Verrill after the present article was sent for publication. It is ·07 inch in length, including the palpi. It is elliptical in form, a little broader behind, being two-thirds as broad as long. Ocelli situated over the insertion of the 2d pair of legs, the distance between them equal to half the width of the body. Body orange red, middle portion of the body black-brown, due to the color of the large liver, with a Y-shaped mesial line pale straw yellow in color, formed by the interspace between the two halves of the liver; the forks of the Y clavate. Appendages very pale grass-green. Legs much as in *H. formosa*, but the hairs are longer. Maxillary palpi the same as in *H. formosa*, there being two pairs of minute spines on the 4th palpal joints. Mouth and lancet-formed organ (languette) protruded as in *H. formosa*. "Bifid linguette" at the base of maxillary palpi, as in *H. formosa*. The rudimentary mandibles form a conical protuberance, the base situated within the body, each mandible being twice as long as broad, and reaching to the basal third of the 2d maxillary joint.

Twelve eggs, ten of them fully formed, being as long as the basal joints of the legs, could be seen on the under side of the body. The mite was alive Dec. 30, showing that the eggs, probably laid in the spring, are formed in the preceding autumn.

With the exception of Philippi's *Pontarachna punctulatum* (Wiegmann's Archiv, vol. vi, p. 191, 1840, Pl. iv, fig. 4, 5), which was discovered by him in the bay of Naples (he does not state at what depth, consequently I infer that it was in shallow water), the species under consideration is the only one which, so far as I am aware, has been found to be exclusively marine. The genus Pontarachna is very different from Hydrachna and Thalassarachna, and I should judge that it rather approaches Atax. It differs from Thalassarachna in the shorter, unarmed palpi, and in the apparent (Philippi does not mention or figure them) absence of a mandibular beak. The palpi are half as long as the fore legs.[*]

The present species was dredged by Prof. Verrill in 20 fathoms, on Clark's Ledge, in Eastport Harbor. It was found (four or five specimens, young and adult), "on hydroids," &c. It will be an interesting point to determine whether, like the other species of the genus, it also lives in the earlier, or even in the adult state among the gills of Lamellibranchs, and also whether it lives between tide marks, thus agreeing with the distribution of *Chironomous oceanicus.* At any rate we have here an insect and a mite breathing by tracheæ, and extracting the oxygen from the water at the great depth of 120 feet, and, in the case of the dipterous larva, with no apparent variation from specimens living at low-water mark. In this connection I might notice the fact that we have on our New England and Labrador shores several species of mites of the family Trombididæ, which run over seaweeds and live under stones between tide marks, and I have observed similar species at Beaufort, N. C., and Key West, Florida.

As regards the distribution of the species of brine insects, several questions of interest arise. How are we to account for the origin of the *Ephydra halophila* in such prodigious quantities in the vats of the Equality Salt Works of Illinois, a locality remote from salt lakes and the ocean shores? Are the brine species of the Salt Lakes of Utah and California, remnants of an oceanic fauna, and of the tertiary period, or are they of recent and local origin? Have these brine insects acquired their singular tastes within a recent geological period (say the Quaternary), having lived at first as do their allied species, in foul fresh water, or amid decaying matter in damp localities? Before these and other questions can be answered, we must have analyses of the waters, and a review of the European literature of the subject,* and larger collections of brine animals from our own country.

Peabody Academy of Science, Salem, Nov. 16, 1870.

## ART. XVIII.—*On the existence of the Nummulitic formation in China;* by Baron VON RICHTHOFEN. (From a letter to Prof. J. D. WHITNEY, dated Su-Chan, China, Dec. 12th, 1868).

THE subject of this letter is the discovery of the *occurrence of the Nummulitic formation in China*, a fact which adds one more to the short series of formations known, chiefly by the labors of Mr. Pumpelly, to enter into the composition of this country.

Mr. Pumpelly cites, on the strength of a statement by Rev. Mr. Edkins, the island of Si-Tung-ting in Tai-hu lake (a sheet of water of about eight hundred square miles, sixty miles west of Shanghai), as a fossiliferous locality. As he learned that the fossils were found in limestone, he was naturally led to the conclusion that this rock formed part of the wide-spread Devonian limestone. Inquiries which I made in Shanghai confirmed the fact of the occurrence of fossils. There, too, they were considered as Devonian, and I was advised by a really skillful geologist, to study their mode of occurrence, as this would give me the clue for the structure of most portions of

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* I am indebted to Mr. F. Walker of London for the following note on the habits of the English species of Ephydra and its allies. He writes under date of Dec. 6, 1870. "I have observed species of Ephydra along the sea shore as well as several inland aquatic species. I am indebted to my friend, the late A. H. Haliday, for the descriptions of the species of this and the neighboring genera in my Diptera Britannica, vol. 2. I am not aware that the species are very different in their habits, and he does not mention them as such. He writes of the following species as occurring on the sea shore.

*Heccameda albicans*, on sandy coasts, especially on fresh rejectamenta.
*Hydrellia thoracica*, on the sea coast.
*Atissa pygmæa*, in a salt marsh.
*Glenanthe ripicola*, muddy sea coast.
*Scatella sibillans*, sea coast.
" *leucostoma*, marine rejectamenta.
" *æstuans*, among fuci.
" *despecta*, sea coast and sandy places.

*Teichomyza fusca*, on chalk cliffs a little above high water mark; swarms also occur in urinatories in London and other towns. Von Heyden, in the Entomologische Zeitung, Stettin, mentions *Cœnia halophila* as a sea-side insect. I believe that no European Stratiomys has been discovered to live as a larva in sea brine."

China, in particular to the mode of occurrence of the Devonian limestone.

I consequently visited the place a few days ago, on a journey overland from Ningpo to Ching-kiang. As no limestone of more recent age than the Devonian was heretofore known in China, I was much surprised to meet with nummulites almost at first sight, and afterward I found the rock in places nearly made up of them. The rock is well exposed to view by enormous quarries, which appeared to have been worked for an immensely long time. The weathered surface of those fragments covering the more ancient waste-dumps shows the structure of the shells with remarkable distinctness, even the minute pores being clearly recognizable with a glass, so that there can not be the least doubt in regard to the true character of the fossil. Several species of Nummulina appear to be represented, as is indicated by the differences in shape of the cross-sections.

As Nummulites are characteristic only of one distinct part of the Eocene period, the fact of their occurrence should be sufficient evidence for the determination of the age of any rocks in which they are met with. But I found myself now in face of the strange fact, that it was partly on the strength of its fossils that the limestone in question had heretofore been considered as Devonian. I attempted therefore to collect its fauna more fully. I found the rock in places full of fossils, mostly bivalves and gasteropods, which have by no means a Paleozoic appearance. They are in an excellent state of preservation, the shells being only bleached. But the limestone is so hard and brittle that I destroyed nearly every specimen which I tried to save; yet I succeeded in getting a few good ones of bivalves. The forms of these fossils, as well as their state of preservation, reminded me much of similar occurrences in the Nummulitic limestone of Dalmatia. Besides gasteropods and bivalves, there occur corals and fragments of very large encrinites. Some of the former which I collected can probably be determined. But I failed to discover a single brachiopod, which are almost the only fossils supposed to be characteristic of the Devonian limestone of China. I presume that indistinct fragments of bivalves, which are usually all that can be obtained, have given rise to the belief of the occurrence of brachiopods on the Si-Tung-ting. Perhaps, too, real brachiopods may have been derived from other places in or near Tai-hu lake, as it is quite possible that true Devonian limestone may occur in the neighborhood.

The nummulitic limestone of Si-Tung-ting is very bituminous. It is burnt in kilns and emits a remarkably strong smell. Its thickness cannot be accurately determined, but it is certainly not more than six hundred feet. Its beds are nearly horizontal, and rest on ancient sandstones, the strata of which are inclined at an angle of about twenty degrees. These sandstones are supposed by Mr. Kingsmill to have a thickness of about ten thousand feet.

Before visiting Si-Tung-ting, I had observed the occurrence of limestone in the neighborhood of the sea coast, near Hang-chau in the province of Che-Kiang, a place mentioned in Mr. Pumpelly's list of localities distinguished by the occurrence of useful minerals. As it rests there quite unconformably on sandstone similar to that which underlies it at Tung-ting, and has a similar lithological character, I believe that I may safely refer it to the same formation with that of Tung-ting. I shall hence look out for its further distribution in China. The subject is not without some practical interest, in a country where all limestone was assumed to underlie the coal and iron-bearing formations.

In 1861, the easternmost place where the Nummulitic formation was known to occur was northern India. I succeeded in that year in proving its existence so far east as Japan and the Philippines, a notice of which you may find in a paper published in the Jahrbuch der deutschen geologischen Gesellschaft of 1861 or 1862. I do not know whether the same formation has since then been found in the regions intermediate between those two countries and India. The occurrence in lake Tai-hu is one of the connecting links, and it is now quite likely that this interesting formation, occurring in places so far apart, is among the most widely distributed in Eastern Asia; and it is quite possible that one unbroken area of submergence may be proved to have extended during the short existence of the genus Nummulina, from Spain to the Philippines and Japan.

I may add, as a sort of voucher for the correctness of my observation, that its communication places me into the disagreeable position of taking opposite views from those of Mr. Kingsmill, a gentleman who has, besides his professional activity as architect in Shanghai, worked of late years with admirable success in the geology of some parts of China. He informed me, some time before I visited Tung-ting, that he had sent a paper on the geology of that locality to the London Geological Society, in the Journal of which it may be printed by this time. The views which he informed me he had taken therein are, that the limestone of Tung-ting is Devonian or Subcarboniferous, and that the great sandstone formation, which plays a very important part in the geology of Eastern China, preceded it in age. The relations observed at Si-Tung-ting do no longer justify this conclusion, after the discovery of the nummulites, and the age of the sandstone (Tung-ting-grits of Mr. Kingsmill) must therefore be considered as not yet safely established. Mr. Kingsmill has, however, succeeded in collecting some remains of plants in the upper layers of the sandstone, and it is to be hoped that they will suffice to determine its age. The state of the weather prevented me from hunting for the locality where he found them.

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## Art. XIX.—*Note on the Infusoria Flagellata and the Spongiæ Ciliatæ;* by Prof. H. James-Clark, Kentucky University, Lexington, Ky.

I send this note in hopes that it may be of interest to those readers of this Journal who have followed the recent discussions upon spontaneous generation and the doctrine of evolution. It is an effort to clear up the chaos of uncertainty which has reigned among the lower Protozoa for years past, and particularly in the heterogeneous group of so-called Sponges. The aim of the Evolutionists is clearly, by refusing to recognize their truly organized structure, to depress these creatures to such a low level in grade, that they shall appear but a step above the lifeless protoplasm which some think has been seen *almost* manufactured in the laboratory of the chemist. After hypothetically developing "organizable protoplasm" out of "inferior types of organic substances," which in the process, *per se*, under "the mutual influences" of its metamorphic forms, generates still more *sensitive* organic matter, until it finally attains to the possession of *vital* actions, the evolutionist imagines himself able "deductively to bridge the interval" between the so-called "nascent life" and the unmistakable vitalism of the slimy Rhizopod (see Herbert Spencer, Appleton's Journal, Aug. 7th 1869, p. 598.)

My own researches have constantly tended in the opposite direction. In spite of the apparent physical simplicity of even the lowest of the Protozoa (Amœba and the like), their habits and the phenomena attendant upon their mode of locomotion, their determinate prehensile acts, so wonderfully like consciousness of an end to be accomplished, and their undeniably specialized digestive functions, all lead to the conclusion, which with me is a fact, that they possess a degree of differentiation in *esse* as marked as that which we recognize as *potential* in the earliest stage of the vertebrate embryo. In the former, the organization is present, but not circumscribed into regions; in the latter it is also present uncircumscribed, but it is to be eventually differentiated. The Sponges, with their supposed slimy, protoplasm-like simplicity, have been in former years the hunting ground of the developmentalists, but of late, that group has been slipping out from under the feet of those philosophers.

Carter first detected the true *criterion* of their animality, though erring as to their classificatory relationship. It was my good fortune to prove their close alliance with the *Flagellata*, in a memoir (Mem. Boston Soc. Nat. Hist., vol. i, pt. III, Sept. 1867, *On the Spongiæ Ciliatæ as Infusoria Flagellata*), published some few years ago. I described certain monad-like infusoria which possessed a single *flagellum* surrounded by a projecting membranous collar. Some forms were appended to branching stems (*Codosiga*) and others were ensheathed in a funnel-shaped or urnæform tube (*Salpingœca*). The monadiform body of these I showed to be identical with the ciliate bodies of one of the *Spongiæ Ciliatæ* (*Leucosolenia*), and homologised the branching stem and the ensheathing tubes of the former with the gelatinous mass of the latter, into which its monads were imbedded. The connection seemed not even a step wide, so clear and unmistakable was the relationship. That there should ever be discovered a form which would lie so intermediate between these as to make me hesitate whether it belonged to the one or the other, I did not even hope for; but it has come unexpectedly. In Schultzes Archiv. für Mikroskopische Anatomie, (Bd. VI, 4, 1870), Cienkowsky describes, under the name *Phalansterium*, a genus which consists of monad-like bodies with a *flagellum* and a projecting collar like those of *Codosiga*, *Salpingœca* and *Leucosolenia*. Of the two species which he illustrates, one (*P. consociatum*) has monads enveloped in a broad funnel-shaped, slimy sheath, and these sheaths are closely packed side by side, radiatingly, so as to form a shield-like or a hemispherical mass. This comes nearest to the *Salpingœca*. The other species (*P. intestinum*) possesses similar monads, but they are imbedded basally in a gelatinous, intestiniform mass of slime (*Schleim*) " with their vibrating lashes extending in every direction " about the cylindrical colony. Originally each monad is endowed with a separate slime-sheath; but eventually these all are fused together into one common mass. Beyond this, to make a true Sponge we need but the presence of spiculæ, and open interspaces in the slimy mass, between the monads, leading to one common cavity. Introvert the layer of monads and we produce the desired effect without doing violence to their relative positions. It is a mere matter of proportions, just as the inverted cyathiform rose-hip is none the less an ovariferous disc than the globular receptacle of the strawberry.

## ART. XX.—*Memoir of Thomas Graham;* by Prof. JOSIAH P. COOKE, Jr.*

IT would be difficult to find in the history of science a character more simple, more noble, or more symmetrical in all its parts than that of THOMAS GRAHAM, and he will always be remembered as one of the most eminent of those great students of nature, who have rendered our Saxon race illustrious. He was born of Scotch parents in Glasgow in the year 1805, and in that city, where he received his education, all his early life was passed. In 1837 he went to London as Professor of Chemistry in the newly established London University now called University College, and he occupied this chair until the year 1855, when he succeeded Sir John Herschel as Master of the Royal Mint, a post which he held to the close of his life. His death, on the 16th of September last, at the age of sixty, though occasioned by a severe cold, was really the wearing out of a constitution enfeebled in youth by excessive labor, voluntarily undertaken and courageously borne, that he might devote his life to scientific study. As with all earnest students, that life was uneventful, if judged by ordinary standards; and the records of his discoveries form the only materials for his biography. Although one of the most successful investigators of Physical Science, the late Master of the Mint had not that felicity of language or that copiousness of illustration, which added so much to the popular reputation of his distinguished contemporary, Faraday; but his influence on the progress of science was not less marked or less important. Both of these eminent men were for a long period of years best known to the English public as teachers of Chemistry, but their investigations were chiefly limited to physical problems; yet, although both cultivated the border ground between Chemistry and Physics, they followed wholly different lines of research. While Faraday was so successfully developing the principles of electrical action, Graham with equal success was investigating the laws of molecular motion. Each followed with wonderful constancy, as well as skill, a single line of study from first to last, and to this concentration of power their great discoveries are largely due.

One of the earliest and most important of Graham's investigations, and the one which gave the direction to his subsequent course of study, was that on the diffusion of gases. It had already been recognized that impenetrability in its ordinary sense is not, as was formerly supposed, a universal quality of matter. Dalton had not only recognized that aëriform bodies exhibit a positive tendency to mix, or to penetrate through each other, even in opposition to the force of gravity, but had made this quality of gases the subject of experimental investigation. He inferred, as the result of his inquiry, "that different gases afford no resistance to each other; but that one gas spreads or expands into the space occupied by another gas, as it would rush into a vacuum; at least, that the resistance which the particles of one gas offer to those of another is of a very imperfect kind, to be compared to the resistance which stones in the channel of a stream oppose to the flow of running water." But although this theory of Dalton was essentially correct and involved the whole truth, yet it was supported by no sufficient evidence, and he failed to perceive the simple law which underlies this whole class of phenomena.

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* From the Proceedings of the American Academy of Arts and Sciences, vol. viii, May 24, 1870.

Graham, "on entering on this inquiry, found that gases diffuse into the atmosphere with different degrees of ease and rapidity." This was first observed by allowing each gas to diffuse from a bottle into the air through a narrow tube in opposition to the solicitation of gravity. Afterwards an observation of Doebereiner on the escape of hydrogen gas by a fissure or crack in a glass receiver caused him to vary the conditions of his experiments, and led to the invention of the well known "Diffusion Tube." In this simple apparatus a thin septum of plaster of Paris is used to separate the diffusing gases, which, while it arrests in a great measure all direct currents between the two media, does not interfere with the molecular motion. Much later, Graham found in prepared graphite a material far better adapted to this purpose than the plaster, and he used septa of this mineral to confirm his early results, in answer to certain ill-considered criticisms in Bunsen's work on Gasometry. These septa he was in the habit of calling his "atomic filters." By means of the diffusion tube Graham was able to measure accurately the relative times of diffusion of different gases, and he found that *equal volumes of any two gases interpenetrate each other in times which are inversely proportional to the square roots of their respective densities*, and this fundamental law was the greatest discovery of our late foreign associate. It is now universally recognized as one of the few great cardinal principles which form the basis of physical science.

It can be shown, on the principles of pneumatics, that gases should rush into a vacuum with velocities corresponding to the numbers which have been found to express their diffusion times; and, in a series of experiments on what he calls the "*Effusion*" of gases, Graham confirmed by trial this deduction of theory. In these experiments a measured volume of the gas was allowed to find its way into the vacuous jar through a minute aperture in a thin metallic plate, and he carefully distinguished between this class of phenomena and the flowing of gases through capillary tubes into a vacuum, in which case, however short the tube, the effects of friction materially modify the result. This last class of phenomena Graham likewise investigated, and designated by the term "Transpiration."

While, however, it thus appears that the results of Graham's investigation were in strict accordance with Dalton's theory, it must also be evident that Graham was the first to observe the exact numerical relation which obtains in this class of phenomena, and that all-important circumstance entitles him to be regarded as the discoverer of the law of Diffusion. The law, however, as first enunciated, was purely empirical, and Graham himself says that something more must be assumed than that gases are vacua to each other, in order to explain all the phenomena observed; and according to his original view this representation of the process was only a convenient mode of expressing the final result. Such has proved to be the case.

Like other great men, Graham built better than he knew. In the progress of physical science during the last twenty-five years, two principles have become more and more conspicuous, until at last they have completely revolutionized the philosophy of Chemistry. In the first place it has appeared that a host of chemical as well as of physical facts are coördinated by the assumption that all substances in the state of gas have the same molecular volume, or, in other words, contain the same number of molecules in a given space; and in the second place, it has become evident that the phenomena of heat are simply the manifestations of molecular motion. According to this view, the temperature of a body is the *vis viva* of its molecules; and, since all molecules at a given temperature have the same *vis viva*, it follows that the molecules must move with velocities which are inversely proportional to the square roots of the molecular weights. Moreover, since the molecular volumes are equal, and the molecular weights therefore proportional to the densities of the aëriform bodies in which the molecules are the active units, it also follows that the velocities of the molecules in any two gases are inversely proportional to the square roots of their respective densities. Thus the simple numerical relations first observed in the phenomena of diffusion are the direct result of molecular motion, and it is now seen that Graham's empirical law is included under the fundamental laws of motion. His investigation has become the basis of the new science of molecular mechanics, and his measurements of the rates of diffusion prove to be the measures of molecular velocities.

From the study of diffusion, Graham passed by a natural transition to the investigation of a class of phenomena, which, although closely allied to the first, as to the effects produced, differ wholly in their essential nature. Here also he followed in the footsteps of Dalton. This distinguished chemist had noticed that a bubble of air separated by a film of water from an atmosphere of carbonic anhydride, gradually expanded until it burst. In like manner a moist bladder, half filled with air, and tied, if suspended in an atmosphere of the same material, becomes in time greatly distended by the insinuation of this gas through its substance. This effect cannot be the result of simple diffusion; for it is to be remembered that the thinnest film of water, or of any liquid, is absolutely impermeable to a gas as such; and, moreover, only the carbonic anhydride passes through the film, very little or none of the air escaping outward. The result depends, first, upon the solution of the carbonic anhydride by the water on one surface of the film; secondly, on the evaporation into the air, from the other surface, of the gas thus absorbed. Similar experiments were made by Drs. Mitchell and Faust, and others, in which gases passed through a film of india-rubber, entering into a partial combination with the material on one surface, and escaping from it on the other.

Graham not only considerably extended our knowledge of this class of phenomena, but also gave us a satisfactory explanation of the mode in which these remarkable results are produced. He recognized in these cases the action of a feeble chemical force, insufficient to produce a definite compound, but still capable of determining a more or less perfect union, as in the case of simple solution. He also distinguished the influence of mass in causing the formation or decomposition of such weak chemical compounds. The conditions of the phenomena under consideration are simply these:—

First. A material for the septum capable of forming a feeble chemical union with the gas to be transferred.

Secondly. An excess of the gas on one side of the film and a deficiency on the other.

Thirdly. Such a temperature that the unstable compound may form at the surface, where the aëriform constituent is present in large mass, while it decomposes at the opposite surface, where the quantity is less abundant.

One of the most remarkable results of Graham's study of this peculiar mode of transfer of aëriform matter through the very substance of solid bodies was an ingenious method of separating the oxygen from the atmosphere. The apparatus consisted simply of a bag of india-rubber, kept distended by an interior framework, while it was exhausted by a Sprengel pump. Under these circumstances the selective affinity of the caoutchouc determines such a difference in the rate of transfer of the two constituents of the atmosphere that the amount of oxygen in the transpired air rises to forty per cent, and by repeating the process nearly pure oxygen may be obtained. It was at first hoped that this method might find a valuable application in the arts, but in this Graham was disappointed; for the same result has since been effected by purely chemical methods, which are both cheaper and more rapid.

These experiments on india-rubber naturally led to the study of similar effects produced with metallic septa, which, although to some extent previously observed in passing gases through heated metallic tubes, had been only imperfectly understood. Thus, when a stream of hydrogen or carbonic oxide is passed through a red-hot iron tube, a no inconsiderable portion of the gas escapes through the walls. The same is true to a still greater degree when hydrogen is passed through a red-hot tube of platinum, and Graham showed that through the walls of a tube of palladium hydrogen gas passes, under the same conditions, almost as rapidly as water through a sieve. Moreover, our distinguished associate proved that this rapid transfer of gas through these dense metallic septa was due, as in the case of the india-rubber, to an actual chemical combination of its material with the metal, formed at the surface, where the gas is in excess, and as rapidly decomposed on the opposite face of the septum. He not only recognized as belonging to this class of phenomena the very great absorption of hydrogen by platinum plate and sponge in the familiar experiment of the Doebereiner lamp, but also showed that this gas is, in some cases at least, a definite constituent of meteoric iron,—a fact of great interest from its bearing on the meteoric theory.

We are thus led to Graham's last important discovery, which was the justification of the theory we have been considering, and the crowning of this long line of investigation. As may be anticipated from what has been said, the most marked example of that order of chemical compounds, to which the metallic transpiration of aëriform matter we have been considering is due, is the compound of palladium with hydrogen. Graham showed that when a plate of this metal is made the negative pole in the electrolysis of water, it absorbs nearly one thousand times its volume of hydrogen gas,—a quantity approximately equivalent to one atom of hydrogen to each atom of palladium. He further showed that the metal thus becomes so profoundly altered as to indicate that the product of this union is a definite compound. Not only is the volume of the metal increased, but its tenacity and conducting power for electricity are diminished, and it acquires a slight susceptibility to magnetism, which the pure metal does not possess. The chemical qualities of this product are also remarkable. It precipitates mercury from a solution of its chloride, and in general acts as a strong reducing agent. Exposed to the action of chlorine, bromine, or iodine, the hydrogen leaves the palladium and enters into direct union with these elements. Moreover, although the compound is readily decomposed by heat, the gas cannot be expelled from the metal by simple mechanical means.

These facts recall the similar relations frequently observed between the qualities of an alloy and those of the constituent metals, and suggest the inference made by Graham, that palladium charged with hydrogen is a compound of the same class, —a conclusion which harmonizes with the theory long held by many chemists, that hydrogen gas is the vapor of a very volatile metal. This element, however, when combined with palladium, is in a peculiarly active state, which sustains somewhat the same relation to the familiar gas that ozone bears to ordinary oxygen. Hence Graham distinguished this condition of hydrogen by the term "Hydrogenium." Shortly before his death a medal was struck at the Royal Mint from the hydrogen palladium alloy in honor of its discovery: but although this discovery attracted public attention chiefly on account of the singular chemical relations of hydrogen, which it brought so prominently to notice, it will be remembered in the history of science rather as the beautiful termination of a life-long investigation, of which the medal was the appropriate seal.

Simultaneously with the experiments on *gases*, whose results we have endeavored to present in the preceding pages, Graham carried forward a parallel line of investigation of an allied class of phenomena, which may be regarded as the manifestations of molecular motion in *liquid* bodies. The phenomena of diffusion reappear in liquids, and Graham carefully observed the times in which equal weights of various salts dissolved in water diffused from an open-mouth bottle into a large volume of pure water, in which the bottle was immersed. He was not, however, able to correlate the results of these experiments by such a simple law as that which obtains with gases. It appeared, nevertheless, that the rate of diffusion differs very greatly for the different soluble salts, having some relation to the chemical composition of the salt which he was unable to discover. But he found it possible to divide the salts into groups of equi-diffusive substances, and he showed that the rates of diffusion of the several groups bear to one another simple numerical ratios.

More important results were obtained from the study of a class of phenomena corresponding to the transpiration of gases through india-rubber or metallic septa. These phenomena, as manifested in the transfer of liquids and of salts in solution through bladder, or a similar membrane, had previously been frequently studied under the names of exosmose and endosmose, but to Graham we owe the first satisfactory explanation. As in the case of gases, he referred these effects to the influence of chemical force, combination taking place on one surface of the membrane, and the compound breaking up on the other, the difference depending, as in the previous instance, on the influence of mass. He also swept away the arbitrary distinctions de by previous experimenters, showed that this whole class phenomena are essentially similar, and called this manifesta- n of power simply "osmose."

While studying osmotic action, Graham was led to one of his ost important generalizations,—the recognition of the crystal- e and amorphous states as fundamental distinctions in chem- ry. Bodies in the first state he calls crystalloids; those in e last state, colloids (resembling glue). That there is a dif- rence in structure between crystalloids, like sugar or feldspar, d colloids, like barley candy or glass, has of course always en evident to the most superficial observer; but Graham was e first to recognize in these external differences two funda- entally distinct conditions of matter not peculiar to certain bstances, but underlying all chemical differences, and appear- g to a greater or less degree in every substance. He showed at the power of diffusion through liquids depends very much these fundamental differences of condition,—sugar, one of e least diffusible of the crystalloids, diffusing fourteen times ore rapidly than caromel, the corresponding colloid. He also owed that, in accordance with the general chemical rule, while lloids readily combine with crystalloids, bodies in the same ndition manifest little or no tendency to chemical union. ence in osmose, where the membranes employed are invariably lloidal, the osmotic action is confined almost entirely to crys- lloids, since they alone are capable of entering into that com- nation with the material of the septum on which the whole tion depends.

On the above principles Graham based a simple method of parating crystalloids from colloids, which he called "dialysis," d which was a most valuable addition to the means of chem- al analysis. A shallow tray, prepared by stretching parchment aper (an insoluble colloid) over a gutta-percha hoop, is the only pparatus required. The solution to be "dialyzed" is poured to this tray, which is then floated on pure water, whose volume ould be eight or ten times greater than that of the solution. nder these conditions the crystalloids will diffuse through the orous septum into the water, leaving the colloids on the tray, d in the course of a few days a more or less complete separa- on of the two classes of bodies will have taken place. In this ay arsenious acid and similar crystalloids may be separated om the colloidal materials with which, in the case of poison- g, they are usually found mixed in the animal juices or ssues.

But besides having these practical applications, the method f dialysis in the hands of Graham yielded the most startling sults, developing an almost entirely new class of bodies as the olloidal forms of our most familiar substances, and justifying the conclusion that the colloidal as well as the crystalline condition is an almost universal attribute of matter. Thus, he was able to obtain solutions in water of the colloidal states of aluminic, ferric, chromic, stannic, metastannic, titannic, molybdic, tungstic, and silicic hydrates, all of which gelatinize under definite conditions like a solution of glue. The wonderful nature of these facts can be thoroughly appreciated only by those familiar with the subject, but all may understand the surprise with which the chemist saw such hard, insoluble bodies as flint dissolved abundantly in water and converted into soft jellies. These facts are, without doubt, the most important contributions of Dr. Graham to pure chemistry.

In this sketch of the scientific career of our late Associate, we have followed the logical, rather than the chronological, order of events, hoping thus to render the relations of the different parts of his work more intelligible. It must be remembered, however, that the two lines of investigation we have distinguished were in fact interwoven, and that the beautiful harmony which his completed life presents was the result, not of a preconceived plan but of a constant devotion to truth, and a child-like faith, which unhesitatingly pressed forward whenever nature pointed out the way.

Although the investigations of the phenomena connected with the molecular motion in gases and liquids were by far the most important of Dr. Graham's labors, he also contributed to chemistry many researches which cannot be included under this head. Of these, which we may regard as his detached efforts, the most important was his investigation of the hydrates and other salts of phosphorus. It is true that the interpretation he gave of the results has been materially modified by the modern chemical philosophy, yet the facts which he established form an important part of the basis on which that philosophy rests. Indeed, it seems as if he almost anticipated the later doctrines of types and polybasic acids, and in none of his work did he show more discriminating observation or acute reasoning. A subsequent investigation on the condition of water in several crystalline salts and in the hydrates of sulphuric acid is equally remarkable. Lastly, Graham also made interesting observations on the combination of alcohol with salts, on the process of etherification, on the slow oxidation of phosphorous, and on the spontaneous inflammability of phosphuretted hydrogen. It would not, however, be appropriate in this place to do more than enumerate the subjects of these less important studies; and we have only aimed in this sketch to give a general view of the character of the field which this eminent student of nature chiefly cultivated, and to show how abundant was the [illegible] of truth which we owe to his faithful toil.

Graham was not a voluminous writer. His scientific papers were all very brief, but comprehensive, and his "Elements of Chemistry" was his only large work. This was an admirable exposition of chemical physics, as well as of pure chemistry, and gave a more philosophical account of the theory of the galvanic battery than had previously appeared. Our late associate was fortunate in receiving during life a generous recognition of the value of his labors. His membership was sought by almost all the chief scientific societies of the world, and he enjoyed to a high degree the confidence and esteem of his associates. Indeed, he was singularly elevated above the petty jealousies and belittling quarrels, which so often mar the beauty of a student's life, while the great loveliness and kindliness of his nature closely endeared him to his friends. He was never married, keeping house with a sister at No. 4 Gordon Square, where he dispensed a liberal hospitality, which has been enjoyed by many of our scientific countrymen who have visited London during the last twenty years.

In concluding, we must not forget to mention that most genial trait of Graham's character, his sympathy with young men, which gave him great influence as a teacher in the College with which he was long associated. There are many now prominent in the scientific world who have found in his encouragement the strongest incentive to perseverance, and in his approval and friendship the best reward of success.

## ART. XXI.—*Note on transversely striated muscular fiber among the Gasteropoda*; by W. H. DALL.

IN studying the radula of a species of *Acmæa* (probably *A. Bornëensis* Rve), obtained by Prof. A. S. Bickmore at Amboyna, I noticed, on placing the structure under a power of 100 diameters, that certain of the muscular fibers which adhered to it, when torn from the buccal mass, had a different appearance from the others. On increasing the power to some 800 diameters, it was at once evident that the different aspect of these fasciculi was caused by fine, but clearly defined, transverse striation. Suspecting that it was an optical delusion, caused by a very regular arrangement of the nuclei of the fibres, I subjected the muscle to various tests and to still higher magnifying powers. I also introduced under the same glass, some of the voluntary dorsal muscles of a small crustacean, for comparison. The structure of the ultimate fibers in both appeared to be similar. These seemed to be composed of a homogeneous tube or cylindrical band of translucent matter, with nuclei interspersed at irregular intervals. In neither was there any appearance of separation into transverse disks, as is seen in the striated muscles of vertebrates. That the striated appearance was not due to contraction and folding of the muscle, was evident upon taking a side view of one of the fibers, when the striæ on each side, as well as the intervening elevations, were seen to correspond exactly to each other.

The only perceptible differences between the muscles of the crustacean and the striated muscles of the mollusk, appeared to be that the latter were much more finely striate; the striæ being six to eight times as numerous as in the former, in the same space. No difference between the striated and non-striated muscles of the *Acmæa* could be observed, except in the fact of the striation. In both the nuclei were irregularly distributed. The appearance of the striated fibre reminded one of a string of rhombic beads, which bore no relation to the position of the true nuclei. The striated fibers appeared, after a careful dissection of the parts in a number of specimens, to be the retractors of the radula: they were longer and in narrower bands than the non-striated fibers and comparatively much fewer in number. The striation was most evident toward the middle of the fibers and became evanescent toward their extremities.

Lebert and Robin (Müller's Arch. f. Anat. and Phys., 1846, p. 126) state that the primitive muscular fasciculi of invertebrates often have the nuclei and intervening clear spaces "arranged in such regular order that they might, at the first glance, be mistaken for transversely striated muscular fibers. The latter, however, are actually found in one acephalous mollusk, *Pecten*, (and probably in *Lima* also) and some annelids," and are constantly present in the voluntary muscles of *Crustacea* and *Insecta*. In the further researches of M. Lebert (Annales Sci. Nat., t. xiii, 1850, p. 161) he observes that there is nothing extraordinary in the discovery of transversely striated muscular fiber in *Polyzoa* (*Eschara*) by Milne Edwards, and in *Actinia* by Erdl, since "the further we have pursued the study of the comparative histology of muscular fiber, the more convinced we have become that transversely striated muscular fiber is to be found in a large number of animals of very inferior organization, without regard to their more or less advanced position in the animal kingdom."

Striated muscular fiber has lately been shown to exist in the "tail" or appendix of *Appendicularia* by Moss (Trans. Lin. Soc., vol. xxvii, p. 300). It was already known to exist in *Sagitta* (Eschricht, ov. Salpernæ), in the articulated brachiopoda, (Hancock, Tr. Roy. Soc., 1857, p. 805), and in *Pecten*, (Lebert, Annales Sci. Nat. 1850, 3rd ser., t. xiii, p. 166; and Wagner, hrb. d. vergleich. Anat., t. ii, p. 470, 1847), as well as in *chara* (Milne Edwards, Annales Sci. Nat., series ii, t. iv, p.

I believe, however, that this is the first instance in which has been shown to exist in the class *Gasteropoda;* and this, well as the rarity of such cases among the lower inverteates, is a sufficient apology for bringing forward such an lated fact. Other duties have not yet permitted me to deterne whether this phenomenon is constant throughout the nus, or whether it does or does not occur among allied nera.

## RT. XXII.—*Note to Article I, on the Quaternary of the New Haven Region;* by J. D. DANA.

As my statement in regard to the essential independence of e Connecticut valley glacier, and others, in the Glacial era may misunderstood, I would draw attention to the meaning of the rds "under the Continental glacier" in the note to page 2,— which it is implied that such glaciers are but the inferior rtions of the great Continental glacier. I hold that, while the ry large valleys of the land, like those of the Connecticut d Hudson, had great influence in determining the direction the movement in these valleys, especially that along the axis each, the whole movement must have been more or less modid by the movement of the great northern ice-mass; and that e counteracting influence of a valley depended not only on depth and extent, but also on its direction and slope. The aller transverse valleys caused no modification of the general acier movement; but large transverse valleys gave to the ice in e middle of the channel their own course almost unmodified: not when the great ice-mass had its maximum thickness, at st afterward when it had become thinner and had lost some its motion.

I may allude to one other example, as I believe it is, of a rtly independent glacier—that of the St. Lawrence valley; r the scratches on its rocks correspond mainly with its course, e prevailing direction, according to Dr. Dawson, being northst. It should be said that these scratches are attributed by r. Dawson to *icebergs* in the Glacial era, which are supposed have moved southwestward up the valley, the land being ofoundly submerged for the purpose, so as to allow of a disarge of the ocean over the continent in that direction; and e fact that boulders were transported *up* the valley is given evidence in favor of this view. But, as in the case of the

Connecticut valley, icebergs could not have gathered up stones in the bottom of the valley for transportation; and, further, as the era following the Glacial—the Champlain era—was an era without question of submergence to a depth of at least 500 feet along the St. Lawrence valley, there should have been icebergs succeeding to the great St. Lawrence glacier and made from it before its final melting; and such icebergs may well have been driven up the river, then a broad arm of the sea, and thus have distributed southwestward the stones which had been gathered below by the glacier in the Glacial era, besides accomplishing all else that can rightly be attributed to icebergs.

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## Art. XXIII.—*Auroral Belt of October 24th–25th,* 1870.

There was seen at New Haven on Monday and Tuesday evenings, October 24th and 25th last, and at other distant places, in the United States, a belt of deep rose or crimson color from east to west across the southern sky, which possessed very uncommon, if not altogether novel characteristics,—among which the following may be instanced. *First*, its breadth was extreme. The writer estimated it at fifteen degrees, which is fully three times the ordinary breadth. *Second*, both its color and its consistence were wholly unlike anything seen at this place before, so far as is known, pertaining to this particular class of auroral phenomena. The "Aurora's Bow," as this class is called, has always hitherto displayed a yellowish white, like a mildly illuminated strip of cloud, and with a uniform cloud-consistence, although sometimes—very rarely—broken into parallel cross fleeces moving west. In this instance the bow was an assemblage of a few great masses irregularly bounded and illuminated, and in color resembling the ordinary red streamers deepened and darkened in hue. This color prevailed uniformly without intermixture with any other; but the component masses would progressively fade, without disappearing, and again recover brightness. *Third*, this class of arches has ever been noticed to form with suddenness and rapidity, and in motion southward to a stationary position, in which, after from twenty minutes to an hour, the arch would disappear. But in the present instance the bow was permanent, having, as here seen, the same situation, essentially, among the stars throughout Monday evening and night, and the like on Tuesday evening so far as the prevalent mists of that evening would allow observation. In parts of New Jersey, and south of Philadelphia, it appears to have kept nearly one place for forty-eight hours. *Fourth*, these arches hitherto have occupied the position of small circles in the northern hemisphere; but this occupied, here, a great circle, at least from ten o'clock on Monday night to one o'clock on Tuesday morning,—and approximately, the same for two hours earlier in the evening. This position lay centrally in the circle ugh or near the stars Alpha Aquilæ, Zeta Aquarii. Eta Ceti Gamma Eridani; to which last it extended at midnight of nday and after. At a time during the earlier hours, after nine ock and probably at about half past nine, the accurate ob-ver Mr. Willard J. Gibbs, viewing this from an elevated station, cluded that the arch cut the western horizon at or near W. N., and the eastern not farther from the south than S. 28° E. is would consist only with its being, at that time, a small circle he southern magnetic hemisphere. Its path otherwise and its mination were not noted by Mr. Gibbs. It deserves mention that an observer of trustworthy accuracy describes the position the due southeast, at two minutes before six o'clock, as being at t time nine degrees more south than the then position of the at circle above described would give it. Therefore in compar- mine with any observations made at other places earlier than o'clock New Haven time it would be prudent to allow for the minating point at this place a few degrees of southing compared h the culmination of the circle described,—but not more than ee degrees at nine o'clock and six degrees at eight o'clock.

At about this last mentioned time the belt was carefully located observation made at Burlington, N. J. (115½ miles S. 50° 22′ W. m New Haven), by B. V. Marsh, Esq., who with others observed phenomena during the evening of Monday, and until half an r past midnight (Oct. 24th.) From Mr. Marsh's letters to ofessor Newton descriptive of the belt I make extracts as lows:— "During all this time—say six hours—a crimson arch ore or less perfect) extended from near the N.E. horizon to r the N.W. horizon varying but little in position. At eight lock I noted its position with some care—by the aid of a globe. northern edge (which however was *not* sharply defined or y regular) passed about 25° S. of the zenith, and if continued uld, I thought, have cut the horizon about N. 45 W. The arch band was from 10° to 20° wide, perhaps 15° on an average. e color was a very deep crimson (at times) and was especially spicuous in the N.W. and N.E., although very bright near meridian also. There was in the north an imperfect and her faint arch of streamers of a yellowish white color with a k segment below. Up to half past ten o'clock there was no ving or flashing, but later there was considerable activity that y. Between ten and half past ten the arch seemed to cross the ith a few degrees farther south than at eight o'clock." In a sequent letter Mr. Marsh states "the arch [north edge] would e cut the horizon but little if any N. of East. The crimson light ppeared in nearly the same position the next evening."

eferring these statements concerning the north edge of the belt its central line; it appears that the latter cut the horizon at ut W. 30° N. and E. 15 S. and culminated about S. 22° W., hav- a zenith distance at eight o'clock of 32½°. The culmination New Haven (lat. 41° 18′) at the same absolute time, was near 20 W. and at 44½° in altitude, allowing five degrees and a half thing from the great circle, for the reason just stated, giving a *corrected* difference of parallaxes—21° oblique to the meridians—of 10½°+, and concomitant to a difference of bases or chords of 100¼ miles:—which bring out a height of 339 miles vertical in lat. 37° 18′·4, or 1° 35′ south of Washington. This would imply that the belt, as seen at Washington, culminated more than 19° south of the zenith. According to the printed account of what was seen at that place — a copy of which in manuscript the writer has received from a trusted correspondent, and has given below—that observed distance was, in fact, but 9°;—however, the tendency to underestimate angular distances near the zenith is so universal that it would not be strange or unexpected to find nineteen degrees of zenith distance described as only nine degrees. This view is confirmed, in the present instance, by the analogous contracted estimate of breadth; which is called but 8°, when, from its nearer proximity to Washington than to Burlington, or to New Haven, it might be expected to subtend an angle of at least 16° or 20°. The account from Washington referred to is the following:—

"October 24—There is a very unusual auroral display to night. The northern sky to the elevation of 30° is brilliant with white light; but a distinct feature consists of a band of blood-red color starting from a point only 8° or 10° N. of W. passing 5° S. of the zenith and touching the horizon again a little S. of East. The breadth of the band is about 8°, and it is very strongly defined throughout."—The probability really is, in accordance with what has been suggested, that, instead of 5°, the north edge passed south of the zenith by as much as 10°, and its middle line nearly as much in addition. The foregoing conclusions are thus substantially confirmed by the observation at Washington; and they make the belt to have been about vertical to Richmond in Virginia,—while it must, equally, have been brilliant not only in central Virginia but through the Carolinas. Investigation will doubtless bring to light the means of a yet more complete and accurate determination of the height and position.

The position of the belt on Tuesday evening, the 25th, is thus described in a letter from W. C. Taylor, Esq., of Philadelphia as seen by him at 9h 35m P. M., at a station seven miles E.S.E. from Philadelphia. "The breadth of the crimson was tolerably uniform, having an average of about 12°. The general direction of the most distinct portion would be indicated by a line through Altair, the trapezium in the Dolphin, and 2° north of the southeastern star in the square of Pegasus." By this evidence it appears that the belt held a more northern situation at that time than upon the preceding evening. Mr. Marsh informs me that the same was seen to continue, during the evening without "apparent change of position" and until the next morning, by an acquaintance of his—a citizen of Philadelphia—who was traveling from that city to Richmond. He also states that the brilliant crimson light in the northwest had been seen on Monday morning. The same, it appears by the newspapers, was seen also at Cincinnati on that morning in the northeast, "resembling the lights of an immense re," and also at St. Louis "illuminating the whole heavens as by great conflagration."

It only remains to state respecting the aurora of Monday evenng, as observed by the writer at New Haven, that by eleven o'clock he faint bank of yellowish white light which, together with a ew streamers of a corresponding color, rested low in the north hrough the hours from six till ten and after, had become suddenly eveloped into a glowing sheet that covered the entire western, orthern, and eastern sky,—everywhere striated and pillared in the western parts with red streamers, and with brilliant white, and ale yellow in the northeast and east. All these had as their base low yellowish cloud arching over a well defined dark space, whose upper limit, in contact with the bright arch above it, extended about 55° from west of north to east of north, and 7° or 8° igh near the north. There were radiations which reached up to corona having its position in the ordinary relation to the dipping eedle's direction, and far north of the great east-and-west crimson elt. The illuminated and extended sheet was pervaded by ncessant auroral waves that passed upward with an uncommonly well established and traceable propagation from the cloud arch to he corona, and with an angular velocity estimated to be 112° in a econd. This great and rare magnificence maintained itself till ne hour after midnight, and then, for the time at least, it passed away. A. C. T.

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## SCIENTIFIC INTELLIGENCE.

### I. Chemistry and Physics.

1. *On the Chlorides of Sulphur.*—Hübner and Gueroüt have nvestigated anew the chlorides of sulphur. The chloride $S_2Cl_2$, orresponding to hydrogen peroxide $\Theta_2H_2$, is easily prepared by aturating sulphur with chlorine and distilling the product. A iquid is thus obtained boiling between 136·5–137°, which gave n analysis 47·63 per cent S and 52·48 per cent Cl, the formula $S_2Cl_2$ requiring 47·41 S and 52·6 Cl. The chloride thus obtained was then saturated with dry chlorine, the excess being removed y passing dry $\text{Є}\Theta_2$ through the liquid for three or four hours. A portion of the chloride thus prepared, on oxidation with nitric cid, gave 30·5 per cent S, and 69·3 per cent Cl, the formula $SCl_2$ equiring 31·07 per cent sulphur and 68·93 per cent chlorine. There are therefore, say these authors, two chlorides of sulphur; a on-volatile chloride $Cl_2S$, corresponding to water, and decomposed by heat, $(SCl_2)_2 = S_2Cl_2 + Cl_2$; and a volatile chloride $S_2Cl_2$, obtained from the former, and boiling at 136·5–137°.—*Zeitschr. Chem.*, II, vi, 455, Sept. 1870. G. F. B.

2. *On the soluble and insoluble forms of Sulphur.*—Berthelot has confirmed Lallemand's observation that sulphur, dissolved in carbon disulphide and exposed to sunlight, is converted into the

insoluble variety. But he has also shown that this change may be produced as well by the electric light and by that of burning magnesium, though not by the calcium light. He finds, too, that melted sulphur, fused at 130° and allowed to cool slowly in sunlight, becomes coated with a pellicle of insoluble sulphur; though if cooled in the dark, it remains unchanged. If, however, the solution of sulphur in carbon disulphide be saturated with any body which can cause the inverse conversion, as hydrogen sulphide for example, and the air be carefully excluded, no change takes place on exposure to light. Moreover, in all cases, the sulphur to be converted must first be fused; crystallized octahedral sulphur suffering no change by light. The rays effecting the change are the chemical rays; hence the inactivity of the calcium light.

Berthelot has also examined the thermo-chemical changes resulting from these transformations. For this purpose, it was necessary to determine the quantity of heat evolved or absorbed, 1st, in the solution of the octahedral sulphur; 2d, in the fusion of this sulphur; and 3d, in the conversion of this variety into the insoluble form. The first of these determinations was not difficult; one gram of sulphur, in dissolving in carbon disulphide, absorbs 12·8 calories. The second datum was derived from the observations of Person which show that, in fusing, one gram of octahedral sulphur absorbs 9·4 calories. The third determination was more difficult; the inverse change of insoluble to ordinary sulphur takes place at 112°, and is accompanied by an evolution of heat; but this cannot be applied to the changes at common temperatures. Insoluble sulphur may be converted in the cold, by placing it in contact with a solution of hydrogen sulphide. This action, which alone is too slow for the purpose, may be completed in from 30 to 40 minutes, by adding to the solution of hydrogen sulphide a tenth of its volume of alcohol, no other chemical change being produced. This transformation thus modified, was effected in a calorimeter. As a mean, it appeared that at 18·5°, one gram of insoluble sulphur evolves on conversion, 2·7 calories. Upon dissolving the converted sulphur in $\text{CS}_2$, however, Berthelot found for each gram an absorption of 15·4 calories, nearly one-fourth more than that absorbed by the solution of the octahedral variety. From which he concludes that the freshly converted sulphur is a distinct variety, and gives it the name of *soluble amorphous sulphur.* Under the microscope, it appears in utricular masses like the insoluble sulphur; but in the course of a few hours, crystalline points appear on these masses, and the whole becomes crystalline in a few weeks. A new determination gave an absorption of 13·1 calories for each gram of sulphur; showing that now the amorphous was converted into the crystalline sulphur. Moreover, the amorphous sulphur, when dissolved in $\text{CS}_2$ can be obtained again only as octahedral sulphur. Since, then, the change of the soluble amorphous sulphur into octahedral sulphur is attended with an *absorption* of 2·6 calories, and the change from the insoluble variety into the amorphous soluble form, is attended with an *evolution* of 2·7 ories, sensibly the same quantity, it follows that no change of ıperature accompanies the conversion of insoluble into octa- lral sulphur.

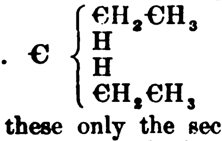
From the data thus obtained, proving that, both in solution 1 when melted, an evolution of heat accompanies the conversion ordinary octahedral sulphur into the insoluble variety, under the luence of light, Berthelot concludes that in these changes, the ht does not effect the work of the transformation, but is simply ; exciting agent.—*Bull. Soc. Ch.*, II, xiv, 106, Aug., 1870.

G. F. B.

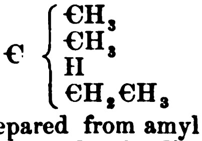
3. *On the remarkable changes of color produced in certain lides by heat.*—In some experiments upon the preparation of uble iodides, Meusel found that on adding a solution of silver rate to one of mercuric iodide in potassium iodide, a bright non-yellow precipitate was thrown down, which, on slightly rming the solution, became intensely orange-red, but regained yellow color on cooling. Further experiments showed that ; same property was possessed by mercuric-cuprous iodide. If a warm solution of mercuric iodide in potassium iodide, copper phate and then sulphurous acid be added, a brilliant carmine- l precipitate is obtained which becomes intensely black on heat- ; to 70°. At first, these bodies were considered to be definite uble iodides; but Meusel, finding that they may be prepared by xing together the separate iodides under water, and that the ecipitated substances may be partially separated mechanically, ncludes that they are mixtures, and accounts for the change of lor by a variation in the absorptive power for light of the silver d the cuprous iodides respectively at different temperatures. Willm and Caventou, on the other hand, maintain that these ecipitates are true double iodides. The cuprous mercuro-iodide, ey assert, gives up nothing to a cold solution of KI, has the defi- ;e formula $Hg(Ȼu_2)I_4$, and yields two definite crystalline pro- cts when treated with ammonia.

Boettger suggests moistening these powders with a little weak m-water and drawing devices with them on paper. The change color by heat is then easily shown as a striking lecture-experi- ;nt.—*Ber. Berl. Chem. Ges.*, iii, 123, 1870. *Bull. Soc. Ch.*, II, i, 220, 1870. *J. pr. Ch.*, II, ii, 136, Aug. 1870. G. F. B.

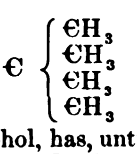
4. *On Tetramethylformene.*—Three isomeric hydrocarbons be- ıging to the marsh-gas series, $Ȼ_nH_{2n+2}$ and containing five ıms of carbon, $Ȼ_5H_{12}$, are theoretically possible:

1. 

$$Ȼ\begin{cases}ȻH_2ȻH_3\\H\\H\\ȻH_2ȻH_3\end{cases}$$

2. 

$$Ȼ\begin{cases}ȻH_3\\ȻH_3\\H\\ȻH_2ȻH_3\end{cases}$$

3. 

$$Ȼ\begin{cases}ȻH_3\\ȻH_3\\ȻH_3\\ȻH_3\end{cases}$$

: these only the second, prepared from amyl alcohol, has, until ently, been obtained. Lwow, under the direction of Professor ıtlerow, has succeeded in forming the third, by acting upon ter- ıry butyl iodide with zinc methyl, according to the equation:

$$(Ȼ(ȻH_3)_3I)_2+Zn(ȻH_3)_2=(Ȼ(ȻH_3)_4)_2+ZnI_2.$$

The zinc methyl was added by drops to the butyl iodide, and the evolved gas washed with dilute HCl, and collected in well-cooled alcohol. On diluting the saturated alcohol solution with water, the new hydrocarbon was evolved as a gas, which, conducted into a well-cooled receiver, condensed to a liquid. This was freed from other hydrocarbons by treatment, first with bromine and then with sodium. Fifty grams of tertiary butyl iodide and 13 grams zinc methyl, gave 15 grams of pure $\text{Ꞓ}_5H_{12}$, almost the theoretical quantity. The hydrocarbon thus obtained is a colorless, mobile liquid, boiling at 9·5°, and solidifying at $-20°$ in crystals, resembling sublimed sal-ammoniac. This remarkable solidification by cold, is characteristic of all highly methylized compounds, as trimethylcarbinol, methyl oxalate, tetramethylbenzol or durol, etc. Analysis established the formula $\text{Ꞓ}_5H_{12}$; a determination of the vapor-density by Hofmann's method, gave 2·495, the calculated density being 2·493. This hydrocarbon, it will be seen, is marsh-gas, in which all four atoms of hydrogen are replaced by methyl. Berthelot's name for marsh-gas being formene, this body has received the name tetramethylformene. It is distinguished from isoamyl hydride by the facility with which it crystallizes. —*Zeitschr. Chem.*, II, vi, 520, Nov. 1870. G. F. B.

5. *On an aromatic glycol.*—Although Wurtz prepared the first glycol, or diatomic alcohol of the fatty series in 1856, yet no similar body belonging to the aromatic series has, until now, been obtained. Such a body Grimaux has recently succeeded in producing. Starting with the fact that xylol, $\text{Ꞓ}_8H_{10}$, may be viewed as di-methyl benzol $\text{Ꞓ}_6H_4\left\{\begin{matrix}\text{Ꞓ}H_3\\ \text{Ꞓ}H_3\end{matrix}\right.$, Grimaux treated it at a boiling heat, with chlorine expecting to obtain either a chloride analogous to ethylidene chloride and corresponding to an aldehyde, $\text{Ꞓ}_6H_4\left\{\begin{matrix}\text{Ꞓ}HCl_2\\ \text{Ꞓ}H_3\end{matrix}\right.$, or one analogous to ethylene chloride, and corresponding to the hydrochloric ether of a glycol, $\text{Ꞓ}_6H_4\left\{\begin{matrix}\text{Ꞓ}H_2Cl\\ \text{Ꞓ}H_2Cl\end{matrix}\right.$. The chloride in question was first prepared in 1867, by acting with chlorine upon xylol obtained from coal-tar, heated to 140°. The yield was very small, however; a fact since accounted for by Fittig's discovery that the xylol from coal-tar is a mixture of 90 per cent isoxylol, and 10 per cent methyl-toluol, from the latter of which alone the above chloride is formed. Investigation having proved that the chloride thus obtained was the second of those given above, Grimaux proposes the name *tollylene* for its radical $\text{Ꞓ}_8H_8$, or $\left(\text{Ꞓ}_6H_4\left\{\begin{matrix}\text{Ꞓ}H_2\\ \text{Ꞓ}H_2\end{matrix}\right.\right)''$. The body $\text{Ꞓ}_6H_4\left\{\begin{matrix}\text{Ꞓ}H_2Cl\\ \text{Ꞓ}H_2Cl\end{matrix}\right.$ is therefore tollylene chloride. By solution in chloroform and crystallization, it is obtained in the form of hard, transparent, rhomboidal prisms, fusing at 100° and distilling above 230°. Heated with water, it yields tollylene glycol; treated with alcoholic solutions of sodium acetate or benzoate, it forms tollylene diacetate or monobenzoate. It yields terephthalic acid by oxidation with potassium dichromate and sulphuric acid. The tollylene glycol,

$_6H_4\left\{\begin{matrix}CH_2\Theta H\\ CH_2\Theta H\end{matrix}\right.$, was obtained from the chloride, as above, by eating it in a close vessel to 170–180° with thirty times its weight f water. The saponification was complete at the end of two ours, and by evaporating the water the glycol crystallized in eedles, which, after purification, were found to fuse at 112–113°, be very soluble in water, alcohol, and ether, and to yield terephalic acid by oxidation. The analogy of these two bodies to thylene glycol and its corresponding acid, Grimaux shows by riting them as follows:

$$\left.\begin{matrix}CH_2\Theta H\\ CH_2\Theta H\end{matrix}\right. \qquad \left\{\begin{matrix}C\Theta\Theta H\\ C\Theta\Theta H\end{matrix}\right. \qquad C_6H_4\left\{\begin{matrix}CH_2\Theta H\\ CH_2\Theta H\end{matrix}\right. \qquad C_6H_4\left\{\begin{matrix}C\Theta\Theta H\\ C\Theta\Theta H\end{matrix}\right.$$

Ethylene glycol. Oxalic acid. Tollylene glycol. Terephthalic acid.

-*Bull. Soc. Ch.*, II, xiv, 133, Aug. 1870. G. F. B.

6. *On the production of solid cresol.*—Wurtz proposed some ime ago, a method for converting the aromatic hydrocarbons into henols. This consisted in treating the hydrocarbons with sulhuric acid, and then decomposing the sulpho-acids thus obtained, y potassium hydrate in excess. In a recent experiment, 300 rams of toluol were converted into cresyl-sulphurous acid, and he potassium cresyl-sulphite fused in a silver basin with a mixure of potassium and sodium hydrates. This fused product, on reatment with hydrochloric acid, yielded 200 grams of crude resol, boiling above 190°, the larger part at 198° to 204°. On ooling these latter products, a solid mass was deposited, which, fter washing with ether, had a brilliant white, lustrous appearnce and a strong odor of phenol. It melted at 34·5° and boiled at 01·5 to 202°.—*Bull. Soc. Ch.*, II, xiv, 6, July, 1870. G. F. B.

7. *On the synthesis of aromatic acids.*—Erlenmeyer and Gütshow having shown that sodium formate, when heated alone, is roken up into hydrogen and sodium oxalate, Victor Meyer conluded that at a certain instant of this change, both hydrogen and he carboxyl group $(C\Theta\Theta Na)'$ existed in the nascent state; and herefore, that if sodium formate were fused with the potassium alt of an aromatic sulpho-acid, its hydrogen would combine with he group $(S\Theta_3K)'$, while its carboxyl group would replace it, ccording to the equation:—

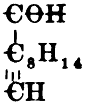
$$RS\Theta_3K+H(C\Theta\Theta Na)=HKS\Theta_3+R(C\Theta\Theta Na).$$

qual quantities of dry sodium formate and potassium phenylulphite were intimately mixed and fused for several minutes, ith constant stirring, in a porcelain dish. The brown mass was issolved in water, acidulated, and distilled, the distillate made lkaline with soda, boiled with animal charcoal to free it from sulhur compounds, concentrated by evaporation, and treated with ydrochloric acid. A copious precipitate of benzoic acid was hrown down, which by recrystallization and sublimation, was btained pure. In another experiment, equal parts of sodium ormate and potassium sulphobenzoate were intimately mixed ogether and then fused. The reaction took place more easily nd uniformly than in the former case, and at a lower temperature. On dissolving the mass in water and acidulating the solution, ether extracted an acid from it which was proved to be isophthalic acid.—*Ber. Berl. Chem. Ges.*, iii, 112, Feb., 1870.

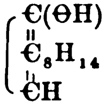
G. F. B.

8. *On the constitution of Camphor.*—VICTOR MEYER has also investigated the constitution of common camphor, which, though the substance has long been known and has been chemically examined repeatedly, has never yet been satisfactorily determined. Of its reactions, the two most important are the production of cymol when acted on by substances capable of withdrawing water from it, and the almost unique production of a dibasic acid by the direct union with it of three atoms of oxygen. The hope of getting some light on this question from the production of phorone alike from calcium camphorate and from acetone, is destroyed by Baeyer's observation that these two phorones are isomeric and not identical. Meyer begins therefore, with the study of camphoric acid. This acid is dibasic; but it possibly does not contain two carboxyl groups, being perhaps an oxy-ketonic acid, containing one carboxyl group, together with the grouping $\begin{matrix}|\\ \mathrm{C\Theta}\\ \mathrm{CH(\Theta H)}\\ |\end{matrix}$, as Weyl has suggested. To test this question, camphoric acid was distilled with soda-lime, in the expectation, that, were two carboxyl groups present, $(\mathrm{C\Theta_2})_2$ would be removed, leaving the hydrocarbon $\mathrm{C_8H_{16}}$. Owing, however, to the low temperature at which camphoric acid breaks up into the volatile anhydride and water, no hydrocarbon was obtained. The observation of Moitessier, however, that copper camphorate yields on dry distillation $(\mathrm{C\Theta_2})_2$ and a hydrocarbon $\mathrm{C_8H_{14}}$, was confirmed; a fact which Meyer regards as making probable the existence of two carboxyl groups. To test Weyl's view positively, the fact that all known ketonic acids are reduced to oxyacids by nascent hydrogen was made use of, and camphoric acid was treated with sodium amalgam for a week; but without change. Lastly, it was proved that no third hydroxyl group was contained in this acid, by heating ethyl camphorate $\mathrm{C_{10}H_{14}\Theta_4(C_2H_5)_2}$ with excess of acetyl chloride in a sealed tube for several days; no change was observed in the ether. From these facts, Meyer gives the formula of camphoric acid as $\mathrm{C_8H_{14}}\left\{\begin{matrix}\mathrm{C\Theta\Theta H}\\ \mathrm{C\Theta\Theta H}\end{matrix}\right.$. Remembering now the second fact above given, that camphor, by loss of water, gives cymol, a homologue of benzol, it is probable that six of its carbon atoms form a main chain, the other four being in the form of lateral chains. Moreover, two of the carbon atoms in the main chain must take up oxygen in its oxidation, else there would be a separation of hydrogen as water; and lastly, the production of cymol shows that the carbon atoms yielding the two carboxyl groups are not united to the same carbon atom. Writing therefore, the formula of camphoric acid $\left\{\begin{matrix}\mathrm{C\Theta\Theta H}\\ \mathrm{C_8H_{14}}\\ \mathrm{C\Theta\Theta H}\end{matrix}\right.$, camphor itself may have

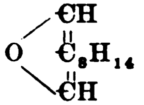
›f the three following formulas :—



$$\begin{array}{c}\text{ЄΘH}\\ |\\ \text{Є}_8\text{H}_{14}\\ \|\\ \text{ЄH}\end{array}$$

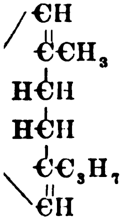


$$\left[\begin{array}{c}\text{Є(ΘH)}\\ \|\\ \text{Є}_8\text{H}_{14}\\ \|\\ \text{ЄH}\end{array}\right.$$



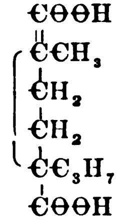
$$\text{O}\begin{array}{c}\diagup\text{ЄH}\\ \|\\ \text{Є}_8\text{H}_{14}\\ \|\\ \diagdown\text{ЄH}\end{array}$$

first of these formulas makes camphor an aldehyde. But view, though proposed long ago by Berthelot, cannot be since Tollens and Fittig showed that camphor possessed none ıe characteristic properties of an aldehyde. According to the ıd formula, camphor contains a hydroxyl group and is a kind lcohol. This is rendered improbable by Berthelot's experi- ;s, who found that while borneol, which is an alcohol, formed ther with acid hydrates, camphor was entirely indifferent to ı. Moreover, Meyer treated camphor with acetyl chloride, glacial acetic acid, and, in alcoholic solution, with hydro- ric acid gas, without changing it in the least. Hence, cam- contains no hydroxyl group. The third formula therefore is ›nly one possible. The constitution of the nucleus $\text{Є}_8\text{H}_{14}$ is ›e interpreted from that of the camphor-cymol, which, as g, Köbrig and Jilke have shown, is either diethylbenzol or ıyl-propyl (or isopropyl) benzol. Adopting the latter view, ıave for the rational constitution of camphor and camphoric , the following formulas:



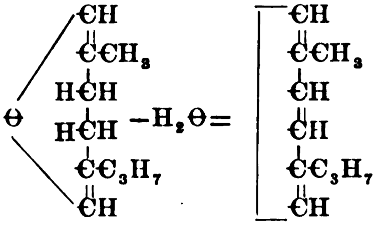
$$\begin{array}{l}\diagup\text{ЄH}\\ \quad\|\\ \quad\text{ЄЄH}_3\\ \text{HЄH}\\ \text{HЄH}\\ \quad\text{ЄЄ}_3\text{H}_7\\ \quad\|\\ \diagdown\text{ЄH}\end{array}$$

Camphor.



$$\begin{array}{c}\text{ЄΘΘH}\\ \left[\begin{array}{c}\text{ЄЄH}_3\\ \text{ЄH}_2\\ \text{ЄH}_2\\ \text{ЄЄ}_3\text{H}_7\end{array}\right.\\ \text{ЄΘΘH}\end{array}$$

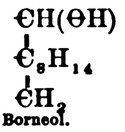
Camphoric acid.



$$\text{Θ}\begin{array}{l}\diagup\text{ЄH}\\ \quad\text{ЄЄH}_3\\ \text{HЄH}\\ \text{HЄH}\\ \quad\text{ЄЄ}_3\text{H}_7\\ \diagdown\text{ЄH}\end{array} -\text{H}_2\text{Θ}= \left[\begin{array}{c}\text{ЄH}\\ \text{ЄЄH}_3\\ \text{ЄH}\\ \text{ЄH}\\ \text{ЄЄ}_3\text{H}_7\\ \text{ЄH}\end{array}\right.$$

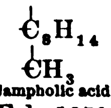
Camphor. Cymol; or Methyl-isopropyl-benzol.

ıe reaction above given explains very simply the formation of ol; by loss of water, the hydrogen-atoms of the third and th carbon atoms take out the oxygen, thus doubly uniting ; carbon atoms and combining the end carbon atoms into ;losed chain characteristic of the aromatic series. Moreover, ıe camphor formula the carbon chain is not closed. Hence, lateral chains remain intact during oxidation; while in true ıatic compounds, which contain closed chains, the lateral ıs are always the ones oxidized. The following formulas are n by Meyer for borneol and for campholic acid.



$$\begin{array}{c}\text{ЄH(ΘH)}\\ |\\ \text{Є}_8\text{H}_{14}\\ |\\ \text{ЄH}_3\end{array}$$

Borneol.



$$\begin{array}{c}\text{ЄΘΘH}\\ |\\ \text{Є}_8\text{H}_{14}\\ |\\ \text{ЄH}_3\end{array}$$

Campholic acid.

ır. *Berl. Chem. Ges.*, iii, 116, Feb. 1870. G. F. B.

9. *A Text-book of Elementary Chemistry, Theoretical and Inorganic;* by GEO. F. BARKER, M.D.—Prof. Barker's excellent treatise has already been briefly noticed in this Journal, and we propose now to call attention somewhat more in detail to its advantages and merits as an elementary work. The first 86 pages are devoted to Theoretical Chemistry, which is here made to include stœchiometry, nomenclature and the general theory of combination. The remainder of the work is occupied with descriptive inorganic chemistry. Each chapter terminates with a series of questions always valuable but particularly useful in making the student thoroughly acquainted with the introductory or theoretical portion of the work, which is wholly in the spirit of the most advanced thought in the science. To the author's nomenclature we take some exceptions. Such terms as *potassium chlorate, calcium phosphate,* &c., though employed by many English chemists at the present day, are, to say the least, of doubtful etymological propriety, and we greatly prefer the corresponding adjective forms, *potassic chlorate, calcic phosphate,* &c., while admitting that these are not always of easy application. Dr. Barker himself occasionally employs the adjective forms, and will, we hope, carry them out systematically in future editions. On the other hand, however, we heartily agree with him in rejecting the absurd term "anhydride," which denotes, not what a substance does but what it does not, contain, and in employing such names as sulphurous and sulphuric oxide for $\mathrm{S}\Theta_2$ and $\mathrm{S}\Theta_3$, nitrous and nitric oxide for $\mathrm{N}_2\Theta_3$ and $\mathrm{N}_2\Theta_5$, &c., adopting the form *carbonic dioxide* for $\mathrm{C}\Theta_2$ to avoid confusion. With the author's original views as to the constitution and nomenclature of the ortho-acids and bases and their derivatives, we also entirely agree. The descriptive part of the work is carefully and judiciously compiled, omitting unnecessary and burdensome detail. Upon the whole we find in Dr. Barker's work a concise, logical and clear treatise, well adapted as a first book, and we sincerely hope that it may be followed by a similar work on Organic Chemistry. W. G.

## II. GEOLOGY AND NATURAL HISTORY.

1. *A Reply to Mr. Dall's criticism on the Brachiopods as a division of the Annelids;* by EDWARD S. MORSE.—The July number of this Journal contained a brief abstract of a verbal communication made by me before the Boston Society of Natural History, on the "Brachiopoda as a division of the Annelida."* I did not expect the concurrence of conchologists to the view there advanced, for I recalled the manner in which an eminent conchologist of England, Mr. Sowerby, received the announcement by Thomson that the Cirripeds were Crustaceans. So in this question, the Conchologists, so far as I am aware, oppose it. While any impartial review would have been answered in my

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* Since republished from this Journal in the Annals and Mag. Nat. History, London.

memoir now in preparation, it seems proper that a reply should be made to a criticism contained in "a Revision of the Terebratulidæ and Lingulidæ, etc.," by Wm. H. Dall, and published in the American Journal of Conchology, vol. vi, part 2. While thanking Mr. Dall for his kindly notice of my labors, and appreciating fully the value of the work he is engaged in, as comprised in his communications to the above named Journal, I am yet compelled to plainly criticize the manner in which he has presented the question in his review.

Mr. Dall says that the "utmost impartiality" should be used in the discussion and "due consideration should be given to the facts," etc. This "utmost impartiality" is illustrated, by passing over in absolute silence, not only all my references to the limited knowledge we possess of the embryology of the Brachiopods as shown by Lacaze Duthiers, but the dorsal and ventral plates—the serial arrangement above and below of setæ, and even the gill laminæ in *Lingula*, as first recognized by Savigny in the annelids—the bi-lobed lophophore—the cephalic collar—the thin and muscular visceral walls—the singular results obtained by Gratiolet in the chemical analysis of the shell of *Lingula anatina*—the presence of the cæcal prolongations of the mantle, and their relations to the *porenkanale* in the annelids—and, above all, the remarkable existence of one or more pairs of *segmental organs*, in form, character and functions like the segmental organs of the annelids, the first feature that led me to regard the Brachiopods as annelids six months before I ever saw living *Lingulæ*. All these points are passed over in the "utmost impartiality" of silence. Overlooking with the same impartiality my statement that the Brachiopods presented a *comprehensive type*, and comprised certain crustacean characters, he neglects to mention the winter egg of the Polyzoa and similar features in the lower Crustacea, and we might add similar features in certain rotifers now admitted to be worms. So also the presence of striated muscular fiber in certain muscles of the Brachiopoda, their absence in the Mollusca, and their presence as one of the prominent characters in Crustacea. He gives us, however, Clark's definition of the Mollusca which comprise the characters of the branch as then understood, which includes of course the Tunicata, Polyzoa and Brachiopoda. In defining the Vermes, with the same impartiality, reference is made only to those Vermes in which the body is made up of a repetition of similar parts, overlooking entirely the unisegmental Vermes which comprise a large proportion of the class; nor is reference made to the remarkable cephalization of many Annelids, where the posterior portion of the body has been called a caudal appendage, being without bristles. In some, the thoracic rings, few in number, have a wide flaring membrane running continuously along each side (*Protula.*)

We leave others to judge of his conclusions respecting the character of the setæ, as also his startling homology of the peduncle of *Lingula*, and the syphonal tubes of a clam (!) and call attention to his statement, that because the setæ are not found the entire length of the peduncle, therefore they are by no means "identical" with those of the worms. This will be a new idea to naturalists, that the confinement of appendages to limited portions of the body, forbids all homology with those in which the appendages run the entire length. It indicates also that Mr. Dall believes that all Chætopods have setæ from head to tail.

He states as a grave objection that the Brachiopods are invariably attached by muscles to a bivalve shell. In the same breath he should have added that worms are also invariably attached to a *bivalve* or multivalve shell, whether it be the scuta of *Sternaspis*, the oval plates of *Lepidonotus*, or the hardened integuments of others.

He lays great stress on the presence of bristles in Chiton, as if that group were the very embodiment of the Molluscan type, but with the same impartiality he neglects to mention its embryology, so remarkably articulate as shown by Lovén, its dorsal vessel, the double and forward opening of the oviducts, the anus terminal, and other features so remarkably articulate, as to induce De Blainville to recognize their affinities with the annelids, to prompt Milne-Edwards to call them a Satellite group, and to cause Jeffries to liken them, in their different stages, to "Isopods, tiny trilobites, Onisci and Aphrodita."

In mentioning my anatomical drawing of various Brachiopods, he says, "some of them taken from life," he should have said, "most of them taken from life."

In concluding his paper he refers to drawings in my collection of a "singular sipunculoid worm," "and appears from them, to have an anterior termination to the intestine, thus forming a notable exception to the general rule among worms." The drawing to which he refers is the common sipunculoid worm of the coast. *Phascolosoma*, *Sipunculus* and its allies claim it as a right to have an anterior termination to the intestine, a fact known to every one who ever made them a study. Finally, in his comparisons, with the exception of Chiton, he confines himself to, and only points out a few of the many relationships between the Brachiopods and Polyzoa and Tunicates, admitted by all. Now since Leuckart, Gegenbaur, Haeckel, and other eminent naturalists of Europe, have seen conclusive reasons to remove the Polyzoa and Tunicates entirely from the Mollusca, and place them among the Vermes, it seems that Mr. Dall's first task should be to whip these back to the Mollusca, before commencing with the Brachiopods.

2. *On Eozoon Canadense;* by Prof. Wm. King, S.C.D., and Thos. H. Rowney, Ph.D., of the Queen's Univ. in Ireland, and the Queen's College, Galway. 42 pp. 8vo, with three colored plates, (Proc. Roy. Irish Acad., July, 12, 1869).—The following Supplementary note to the paper noticed on page 68, was read Feb., 1870.

Within the last fortnight we have been successful in finding "eozoonal" structures under conditions which unmistakably establish their origin.

ave first to notice a specimen of ordinary metamorphic ystalline limestone, from Aker, in Sweden. It contains ıs light green grains of pyroxene of the variety known as ·, a considerable portion of a colorless translucent variety ıted mineral seemingly malacolite, and a few small purple

The grains of coccolite, which have a rude cleavage nating to a sub-conchoidal fracture, are isolated, or form tions, in the calcareous matrix: their surfaces are variously and excavated, giving the grains an irregularly lobulated nce. The occasional presence of planes, edges, and solid ın their surfaces, renders it certain that the grains were ly crystals that have undergone superficial erosion by issolving agent. The spinels, which are in octahedrons, en subject to a similar waste, though not to the same -only occasionally occurring more or less spherical, and )ded surfaces.

ir irregular lobulated character, variety of aggregation, tered arrangement, the grains of coccolite strikingly resem- se of serpentine ("chamber casts") in the "acervuline" of "*Eozoon Canadense*," occurring in Canada. We take ır being the first to point out a precisely similar agreement rains of chondrodite, pargasite, &c., common in the crys- imestones of other places.*

he specimen under notice shows other and additional ers, which still more clearly establish its "eozoonal" rela- s.

ı a slight portion of the matrix is removed by decalcifica- e surface is seen to be crowded with slender cylindrical ıore or less branching, often remarkably beaded, and ar- in all conceivable modes of grouping. They agree in every with the finest typical examples of the "canal system," as ıted by Doctors Carpenter, Dawson, and Professor Rupert

iated with the latter are numerous specimens of the mala- ivided by different sets of cleavage planes, the principal ng them quite a lamellar structure. Occasionally others )proximating more or less to perfect prismatic crystals: erally some of the angles, edges, and planes, have disap- or only traces are observable; so that they present the nce of vermicular rods—straight, bent, or twisted—nodu- irregularly excavated. These configurations exactly an- certain of the so-called "stolons."‡

y be contended, by those from whom we differ on the ques- ıcussed in these pages, that the specimen belongs to an ıal" rock. But, apart from its fatal agreement with other

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rterly Journal of Geological Society," vol. xxii, p. 209.

)awson in "Quarterly Journal of Geological Society," vol. xxi, Pl. VII, 5; Carpenter, ibid, Pl. VIII, fig. 5, *a*, *b*, *c*, and Pl. IX, fig. 5, *a*, *b*, *c*, *d*; nes, "Popular Science Review," vol. iv, Pl. XV, figs. 6, 7, 8.

larpenter, "Quarterly Journal of Geological Society," vol. xxi, Pl. VIII, IX, fig. 3; Jones, "Popular Science Review," vol. iv, Pl. XV, fig. 5.

specimens of the kind in possessing the never-failing crystalline or metamorphic character—how, on such a view, are we to set aside the clear evidences of the "chamber casts" and the "stolons" having been originally crystals?

Besides, not only have these parts had a crystalline origin, but it is equally plain that the same conclusion must embrace the "canal system;" for it is impossible to detect any line of demarcation between the "stolons" and the latter. Dissolving action has, in the first place, converted the crystals of malacolite into the "stolons:" next the crystals were divided by cleavage, and eroded to such an extent that, in the state of the "canal system," they became reduced to mere skeletons.* Respecting the beaded character of the branching forms, we are strongly inclined to believe that it has resulted from the cleavage which transversely cuts the prisms: obviously the erosion would be deepest where it was present.

In no instance have we detected any traces of the "nummuline layer" on the grains—a deficiency we attribute to their component mineral, coccolite, not assuming the fine asbestiform structure which so eminently distinguishes serpentine in its change into chrysotile. There is often, however, a thin whitish granular coat investing the grains, sometimes so compact as to remain after they have been accidentally detached from the matrix.

Another specimen, which is from Amity, New York, consists of a similar calcareous matrix, holding spinel, chondrodite, serpentine, a micaceous mineral, and malacolite. One of the crystals of spinel is a compound octahedron, about two inches in its axial diameters, having part of its faces built up of minute triangular facets, and others, of small implanted octahedrons; both lying parallel to the faces of the large crystal. Numerous linear chinks, and irregularly formed cavities, separate the component triangular facets and octahedrons; and they are filled up with micro-crystalline calcite, similar to that of the matrix, enclosing malacolite. Decalcification brings out beautifully the last-named mineral, which assumes with wonderful exactness all the characters and modifications of the "stolons" and "canal system," as displayed in the Aker specimen; so that the description we have given of them would have to be repeated if we described those under consideration: and were it necessary to represent the latter, our representations would be close *fac-similes* of the figures, already referred to, which Dawson, Carpenter, and Rupert Jones, have published in their respective memoirs.

All the calcite of the specimen equally shows the same "eozoonal" structures; and that they have originated from the waste of crystals of malacolite. One example consists of a prismatic or gitudinally-cleaved mass of this mineral, having at one end the vage prisms diverging, losing their edges, and slightly branch- ; strikingly resembling the case figured in our first memoir,* reminding us of the example of the "canal system," described Dr. Carpenter as "consisting of parallel lamellæ disposed like leaves of a book."†

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* It may be hypothetically suggested that, in the final stage, the crystals have been totally dissolved. Malacolite consists, in round numbers, of silica 56, lime 23, magnesia 17. Assuming carbonic acid to have acted as the solvent, this substance might completely replace the silicic acid, and in this way change the basic constituent of the mineral; making calcite (or dolomite) a pseudomorph after malacolite.

ince it was first announced that we had determined "*Eozoon adense*" to be nothing more than a mineral production, we have along felt that specimens would be found demonstrating more . more completely the truth of our conclusion: but we were ainly not prepared to meet with a large crystal of spinel, hold- in its chinks and cavities typical examples of two of the essen- features of this reputed organism: and these themselves pos- ing evidences indisputably testifying to their purely crystalline gin.

he Aker and Amity specimens show, what we have long sus- ted, as intimated here and there in the preceding paper, that arborescent forms ("canal system") may consist of other sili- es besides serpentine. As to their being composed of anything than a siliceous substance, we are not yet prepared to offer an nion on the matter; though it must not be overlooked that ilar forms, but on a comparatively gigantic scale, are common, sisting of carbonate of lime, in magnesian limestone, near derland, in Durham. We have been led into this subject from erving a recent announcement, by Dr. Sterry Hunt, of *another* overy in "*Eozoon canadense*" (at Chelmsford, near Lowell, S.) of "the canals and tubuli of the calcareous skeleton filled, with a silicate, but with carbonate of lime."‡ On seeing this nouncement, we immediately wrote to Mr. Bicknell, of Salem, ntioned by Dr. Sterry Hunt, asking him to oblige us with speci- ns of the kind. Shortly afterwards we received from Mr. Bick- l, by sample post, a transparent section carefully prepared by self, and a piece of the rock,—both labelled "Chelmsford." re were also specimens of "eozoonal" ophite from Newberry- t, a neighboring locality. In the latter, some of the structures typically exhibited: the fibers of the "nummuline layer," how- r, are more confusedly arranged, and much longer than usual. the former, the serpentine, of a pale-greenish color, is in irregu- y fractured pieces, separated from one another by unusually wide rspaces of calcite ("calcareous skeleton,") which contains bun- s of radiating crystals, also groups of vermicular branching ns ("canals and tubuli"): the "nummuline layer" is not well eloped, being often represented by minute radiating aciculi. have carefully tested the Chelmsford specimens, both by mical reactions and polarized light, without however, detecting evidence of the "canal system" being else than siliceous; or being composed of a substance identical with or related to its

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"Quarterly Journal of Geological Society," vol. xxii, Pl XV, fig. 17, *b*.

"Intellectual Observer," vol. vii, p. 294.

"Scientific Opinion," January 20, 1870, p. 45.

calcareous matrix.* Now, we cannot dispute the statement of Dr. Sterry Hunt; as probably some mistake may have been made in our specimens. We must, however, *in this case too*, complain of the very meagre and unsatisfactory account given of the "canals and tubuli" in the otherwise more detailed notice of the Chelmsford "Eozoon," published in the Am. Journ. of Sci., p. 77, of January last. No evidence whatever is offered to show by what process the chemical nature of these parts was determined;—whether the conclusion that they are of the same composition as the "calcareous skeleton" was based on an examination by polarized light; or whether they do not consist of some soluble silica, or of a mixture of a carbonate and a silicate such as would be quite as readily acted upon by weak acid as their imbedding substance, especially if it be dolomite. We wish to call particular attention to the last point, as brief mention has already been made of a specimen of elæolite (a translucent variety, from Brevig), which, in consequence of its being an alkaliferous silicate of alumina (and there is no reason why such a compound may not occur in the Laurentian metamorphic marbles), was dissolved in weak acid. Another specimen, which we have lately subjected to the same process, was taken out of the solution in a partially digested state. When examined with the microscope, the residuum, which is in a slightly coherent condition, was found to consist of interlacing configurations, some of which, where well separated from the rest, bore no inconsiderable resemblance to the "canal system"—not, it is true, in its beautiful arborescent forms, but in the small crooked branching varieties, common to many Canadian examples. Prismatic cleavage, which elæolite eminently possesses, had evidently favored the development of the configurations. They are transparent, rudely branching and anastomosing, showing rarely any cleavage edges or planes; these for the most part having been emoved by the action of the acid.

Such a case as this clearly necessitates every point being duly considered before any conclusion can be drawn as to the chemical nature of the "canals and tubuli," should they appear not to have their ordinary composition. It also strikingly illustrates the view we have taken that these parts in typical "*Eozoon*" are merely the skeletons of fragments, or of crystals—respectively of serpentine or some other silicate—which remain after their waste had been arrested through changed conditions. Moreover, it testifies to our having succeeded in forming from elæolite, by the action of a weak solvent, configurations approximating to the rude varieties of the "canal system."

3. *Scientific Expedition to the Rocky Mountains.*—The Yale College scientific party, in charge of Professor O. C. Marsh, which left New Haven in June last for the Rocky Mountains, returned to this city on the 18th of December. The party, which was essentially a private one, consisted of Professor Marsh and twelve com-

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* We expect still to receive specimens, undoubtedly identical with those described by Dr. Sterry Hunt; when we hope to announce with more certainty the result of our investigations.

panions, all students or recent graduates of the College. The main object of the Expedition was to investigate the extinct vertebrate fauna of the Tertiary and Cretaceous deposits of the Rocky Mountain country, and the general plan adopted was to make several separate trips, of one or two hundred miles north or south of the Pacific railroad, to regions that were unexplored, or had never been carefully examined.

The first of these was made early in July, from Fort McPherson in Nebraska, to explore the Pliocene deposits along the Loup Fork river. Here rich collections of fossil vertebrates were obtained, and several new species of extinct mammals and birds discovered. The next expedition was made in August, from Fort D. A. Russell in Wyoming, to examine the geology of the country between the North and South branches of the Platte river. On this trip the Mauvaises Terres or "Bad land" formation, with the true *Titanotherium* and *Oreodon* beds was discovered in Colorado,* and traced northward through Nebraska to the North Platte. The fossil remains obtained were also important, and included several species of extinct mammals and birds, new to science.

The third expedition was made from Fort Bridger, Wyoming, in September and October, to examine the geology of the Eastern Uintah Mountains, and the country between the Green and White rivers. In this region interesting geological discoveries were made, and many new Tertiary vertebrate remains secured, which will soon be described by Professor Marsh. On their return, the party went to California, and spent a month in visiting various points of scientific interest; after which they came east to Denver, and thence to Fort Wallace in Kansas. About two weeks were spent in exploring the Cretaceous beds of this vicinity, where some interesting reptilian and fish remains were obtained, and the party then returned to the east.

The Expedition as a whole was very successful, and the large collections made will be placed in the Peabody Museum of Yale College. The more important scientific results will soon be published.

4. *Monograph of the North American Astacidæ;* by Dr. H. A. HAGEN. No. III of the Illustrated Catalogue of the Museum of Comparative Zoölogy. Cambridge, 1870.—Our American crawfish have been much neglected, never having been subjected to thorough study, and, as might be expected, Dr. Hagen has given us an accurate and very valuable monograph. The investigation of the constancy of the specific characters and the sexual peculiarities are highly interesting and form the most important feature of the work. In *Cambarus*, which includes all the species east of the Rocky Mts., the author has found that the first abdominal legs of the male present great and very constant specific differences, similar to those discovered in *Callinectes* by Ordway, and to those in some species of *Achelоüs* and *Cardiosoma.* In this same genus two forms of males are described,—ordinary fully developed in-

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* This Journal, II, vol. 1, p. 292, Sept., 1870.

dividuals, and a second form in which the individuals retain many of the features of the young and are supposed to be sterile. While the second form of males was found in every species of *Cambarus* of which any number of specimens were examined, it was found in none of the species of *Astacus.* This important discovery of dimorphism in the males of *Cambarus* is accredited to Prof. Agassiz. It is mentioned that perhaps the "fact of the existence in the Crustacea of two forms, one always sterile, is not unique," and a short account of dimorphism in other Crustacea and in insects is given. Among the decapods, the author notices the occurrence of sterile females in "*Lupa* and *Callinectes*," and states that he has "found similar females with a narrower triangular abdomen in some other genera of *Brachyura.*" The occurrence of dimorphic sterile females is much more common among the *Brachyura* than this would imply. DeHaan mentions and figures such forms in several species of Portunids, and the writer has noticed them in *Neptunus*, *Acheloüs*, *Epilobocera*, and *Pinnotheres.* In all these cases the abdominal appendages are more or less rudimentary and not well adapted for the attachment of eggs.

Thirty-two species of *Cambarus* and six of *Astacus* are described, and eleven species, all *Cambari* are new. The description of the species is followed by an extended account of their geographical distribution. The author remarks on the absence of crawfish in central and eastern New England and the eastern portion of British America, and does not seem to have been aware of their occurrence in the St. Johns and Aroostook rivers.*

The eleven plates contain figures of the first abdominal legs of the male and some other parts of nearly all the species, from the author's drawings, and beautifully executed figures of the entire animals of eight species. S. I. S.

5. *Preliminary Report on the Crustacea dredged in the Gulf Stream in the Straits of Florida;* by L. F. DE POURTALES, Assist. U. S. Coast Survey. PART I, *Brachyura;* prepared by Dr. WILLIAM STIMPSON. Bulletin of the Museum of Comp. Zool., vol. ii, No. 2. 52 pp. Cambridge, Dec., 1870.—In this important paper, Dr. Stimpson gives a full list of the Brachyura collected by the Coast Survey dredging expeditions of 1867–8–9. 81 species, representing 47 genera, are mentioned, and 52 of the species and 19 of the genera are described as new. More than half the species belong to the Maioidea, while the Ocypodoidea are represented by only two species, both of them belonging to the Carcinoplacidæ. Only a small proportion of the species are from great depths, and the number of new forms seems largely due to the thorough exploration of the shallower waters. But 15 species are recorded as coming from below 100 fathoms, and of these 11 are Maioids, and the other 4 are Cancroids—a *Pilumnus*, 2 species of *Bathynectes* (a new genus allied to *Portunus*) and a species of *Acheloüs.* The

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* Reports on the Natural History and Geology of Maine. In the Museum of Yale College, there are specimens of *Cambarus propinquus* from Montreal and from Madison, Wisc.

greatest depth at which any of the species were found is 150 fathoms; and it is quite remarkable that the only species from that depth were *Portunidæ*—one of the species of *Bathynectes* and the *Acheloüs*. S. I. S.

6. *On the Mineral Constituents of Meteorites;* by N. S. Maskelyne, M.A., Prof. Min. Oxford, and Brit. Mus. (Trans. Roy. Soc., 1870).—Mr. Maskelyne takes up in this paper the analysis of the Busti aërolite of 1852. He finds in it the compound, mono-sulphide of calcium, in small spherules of pale chestnut-brown color, and transparent when pure, to which he gave the name *Oldhamite* in 1862; and minute golden-yellow octahedrons (isometric) named *Osbornite*. The amount of the latter obtained for analysis was too small for completed results; but led to the conclusion that it contains sulphur, calcium and some titanium-like metal, not titanium or zirconium, with a trace of iron. It is infusible, and not acted on by boiling nitric acid, and, heated in a current of dry oxygen, it undergoes only an external oxidation. Mr. Maskelyne calls attention to observations of Prof. Mallett on a gold-yellow incrustation obtained by heating zirconium with lime and aluminum, contained in this Journal, II, xxviii, 346.

The other constitutents of the aërolite were a magnesian enstatite the main part, augite, schreibersite, nickeliferous iron, and a very small proportion of troilite (FeS) and chromite. The augite is a magnesia-lime augite.

The Manegaum meteorite, which fell in 1843, was found by Mr. Maskelyne to consist *of a single silicate, and that enstatite;* the enstatite is a highly ferriferous variety, containing

$$\ddot{\mathrm{Si}}\ 53{\cdot}63,\ \dot{\mathrm{Fe}}\ 20{\cdot}48.\ \dot{\mathrm{Mg}}\ 23{\cdot}32,\ \dot{\mathrm{Ca}}\ 1{\cdot}49,\ \dot{\mathrm{Fe}}\ \dddot{\bar{\mathrm{Cr}}}\ 1{\cdot}03 = 99{\cdot}95.$$

This meteorite contains only a minute amount of meteoric iron.

The investigations show that the flocculent opaque white mineral seen in the microscopic sections of many meteorites is often, if not always, enstatite.

7. *Fossil Mammals of the Rocky Mountains collected by Dr. Hayden;* Dr. Leidy, (Proc. Acad. Nat Sci. of Philadelphia, Oct. 4–18).—Dr. Leidy here brings out many new facts with regard to the Tertiary Mammalian life of this Continent.

On the Sweet Water river, eighteen miles west of Devil's Gate, Wyoming Terr., the bones are mostly of a species of Merycochœrus, smaller than *M. proprius;* but with these there are remains of an equine animal, perhaps a *Hipparion*, and of *Canis vafer* and *Merycodus necatus*, species first described from the Niobrara.

From Fort Bridger there is a molar of apparently a small species of *Lophiodon;* part of a lower jaw of a pachyderm, which is named provisionally *Hyopsodus paulus;* an animal allied to *Chalicotherium* and *Titanotherium*, which Dr. Leidy named *Palæosyops paludosus*, (other specimens of which have been received from Henry's Fork of Green river, Wyoming; a species related to the Peccary, named *Microsus cuspidatus*; and one related to the Raccoon, named *Notharctus tenebrosus*.

8. *Fossil Mammals from Oregon;* J. Leidy, (ib.).—The specimens were from Rev. Thos. Condon of Dalles City, Oregon. Dr.

Leidy observes that the greater number of specimens belong to a species of *Oreodon* larger than any before described, and as large as *Merycochœrus proprius*, with which species it may be identical. He names it *Oreodon superbus*. There are also a few fragments of jaws of *O. Culbertsoni*, *Agriochœrus antiquus*, *Leptomeryx Evansi*, *Anchitherium Bairdi*. The above are from "the Big-bottom of the John Day river." From Bridge Creek, a tributary of the John Day, there are remains of *Lophiodon occidentalis ?*, an animal about the size of *Tapirus terrestris*, two species of Rhinoceros, one the *R. occidentalis ?*, another *R. hesperius ?*, *Elotherium superbum ?*, a Peccary as large as *Dicotyles torquatus*, an *Anchitherium* larger than *A. Bairdi*, called *A. Cordoni*.

9. *Cretaceous and Tertiary Reptilia and Fishes.*—In the Proceedings of the American Philosophical Society, Prof. Cope describes 4 species of Saurocephalus from the Cretaceous of Kansas, 1 of Icthyodectes (n. gen. near Saurocephalus) same locality, and several new fishes, chiefly Cyprinidæ, from a freshwater Tertiary deposit in Idaho discovered by Capt. C. King. Dr. Leidy has observed among mammalian remains from the same beds, portions of *Mastodon mirificus* and *Equus excelsus*, species that occur in the Niobrara beds and which have been referred to the Pliocene. The Mollusks of the beds, according to Meek, are different specifically, and some generically, from all others hitherto described from the West. Prof. Cope, in view of the characters of the fishes, says that there is great probability of the beds being later than Miocene, and nothing to conflict with their being Pliocene.

10. *Geological Survey of Ohio.* Part I, Report of Progress in 1869, by J. S. Newberry, Chief Geologist. Part II, Report of Progress in the Second District, by E. B. Andrews, Assistant Geologist. Part III, Report on Geology of Montgomery County, by Edward Orton, Assistant Geologist. 164 pp. 8vo, with a colored geological map of the state, and sections. Columbus, 1870.—Much interest attaches to the Geological Survey of Ohio, because of the position of the state between New York and the states of the Mississippi basin. The work already done by Dr. Newberry and his able associates has thrown much light on the connection between the two regions, besides adding many new facts with regard to the coal and coal beds of the state. We propose to notice the results at some length in our next number.

11. *Gas Wells in Ohio.*—Dr. Newberry states in a paper in the American Chemist for December, that the two gas wells bored by Mr. P. Neff in the valley of the Kokosing have been flowing gas in apparently undiminished volume to the present time. Other wells have since been opened. Near Millwood where the rocks are much disturbed, two wells give out oil, one three and the other eight gallons per day; two or three miles below, near the mouth of the Kokosing, the augur, on reaching the depth of 600 feet, struck into vertical crevices and sunk several feet without resistance; and from two crevices a volume of carburetted hydrogen issued which was unparalleled in all the oil explorations made in the country; the wells give out salt water intermittently, throw-

ing it to a height of over one hundred feet. The gas of one of the wells, lighted at the end of a pipe two inches in the clear set in the well head, produced a jet of flame 20 feet long and as large as a hogshead. By fixing a stop-cock in the pipe the gas was made to accumulate until, measured by a steam gauge, the pressure amounted to 180 pounds to the square inch. The gas appears to be pure and the volume sufficient to light a large city.

12. *Linnæan Hypothesis of the Derivation of species.*—Ludwig von Hohenbühel-Heufler contributes an article to the *Botanische Zeitung* for Sept. 9, 1870, in which he claims for Linnæus the origination of *the* theory of the derivation of species,—founding the claim upon the paragraphs which Linnæus appended to the sixth edition of his *Genera Plantarum*, published in 1764, viz:

1. "Creator T. O. in primordio vestiit Vegetabile *Medullare* principiis constitutivis diversi *Corticalis*, unde tot difformia individua, quot *Ordines* Naturales, prognata.
2. *Classicas* has (1) plantas Omnipotens miscuit inter se, unde tot *Genera* ordinum, quot inde plantæ.
3. *Genericas* has (2) miscuit Natura, unde tot *species* congeneres, quot hodie existunt.
4. *Species* has (3) miscuit Casus, unde totidem, quot passim occurrunt, *Varietates*.
5. Suadent hæc (1–4) *Creatoris* leges a simplicibus ad composita. *Naturæ* leges generationis in hybridis. *Hominis* leges ex observatis a posteriori.

Whatever meaning be put upon these somewhat enigmatical propositions, they certainly show that Linnæus (as a naturalist of his turn of mind was not unlikely to do) had thought of a derivative origin of species as not improbable, and had formed some idea of an hypothesis concerning it,—perhaps as definite as his idea of natural orders,—a problem he could suggest rather than solve. And it is interesting to note the scale of operating powers,—Chance sufficing for the production of varieties, Nature for genera, the Omnipotent directly for the mightier work of producing orders.

In a subsequent number of the *Bot. Zeitung*, that for November 18, the veteran senior editor, Von Mohl, takes up the subject, and maintains, with much reason, that the theory of Linnæus, whatever it amounts to, has no special likeness to the modern "Descendenztheorie," in any important particular. For, he concludes that the "a simplicibus ad composita" of Linnæus did not involve the idea of a rise in organization from a plant or plants of lowest to those of higher grade, nor did he imagine the diversification to have been a consequence of the inherent powers of the plants themselves, or to be still proceeding, so that the present is any representation of the past. But he thought it necessary to admit a direct interference of the Creator twice, once in the origination of plants representing the natural orders, and then in the supernatural diversification of these by *crossing*, to produce the genera; and only the genera are supposed to have mingled by crossing in virtue of the natural laws of propagation, so as to result in the formation of the existing species, which species Mohl thinks, were regarded by Linnæus as unchangeable since their first appearance, excepting the mere accident of variation by hybridation, etc. So that Linnæus might with full consistency retain his well known definition or axiom: "Species tot sunt, quot diversas et constantes formas in hoc globo prodixit Infinitum Ens," etc., and so this axiom holds its place in the Ratio Operis of the same volume to which, at the close, this hypothesis of the diversification of species is appended. But we can hardly suppose that a philosopher like Linnæus would attribute this diversification as to species to natural causes, and then imagine that existent natural causes had ceased to operate; and he would certainly have seen that the continued crossing of the species of a genus would soon have resulted in the total obscuration of species. If he thought at all of harmonizing his practical definition with his suggested hypothesis, he probably regarded species as having only a relative stability, so as to be essentially unchanged for any period within human ken, whatever their origin or progress in the long run.

To throw some light upon Linnæus's enunciation, which appears so obscure, of an essential *medullary substance*, invested with an accessory *cortical substance* in all plants, Von Mohl makes a long extract from the dissertation of Linnæus upon Generatio Ambigena, published in the 6th vol. of the Amœnitates Academicæ,—a curious speculation which would take some time to explain, one to which Linnæus elsewhere refers, especially in explaining the nature of the blossom, and in which doubtless, as Mohl supposes, is to be found the key to the understanding of his derivative hypothesis. A. G.

13. *Monograph of the Ranunculaceæ of the Dominion of Canada;* by Prof. GEO. LAWSON, Dalhousie College, Halifax, contributed to the Canadian Naturalist.—A full account of this family, with ample details as to geographical distribution, etc. In the character of the tribes the position of the seed is omitted, probably as too difficult for popular apprehension, though it is really easy enough. *Pulsatilla* is kept as a genus, but not *Atvagene*, yet the two would seem to stand or fall together, and *Hepatica* is reduced to *Anemone*. Of the latter genus, the name *A. dichotoma* replaces *A. Pennsylvanica*, "because the latter suggests erroneous ideas of the plant's distribution." We can adduce a far better reason, viz: that it is of almost twenty years later date. In the admission of *Thalictrum clavatum* as a Canadian plant, Prof. Lawson shows that he has not followed up the history of this species, nor noted that in the Manual its northern limit is said to be S. Virginia. He should substitute the name *T. sparsiflorum*, and see, for authority, *Plantæ Wrightianæ*, ii, p. 8, and this Journal, xlii, p. 17, as well as 33, new series, in the account of Dr. Parry's collection. The first and last of these references will throw light also upon the notable peculiarity mentioned in the geographical distribution of *Delphinium exaltatum*, which species, if at all Canadian, is likely to inhabit only the most southern latitude.

A. G.

14. *Œrsted on characters furnished by the styles in Cupuliferæ and Juglandeæ, etc.*—In the Copenhagen *Videnskabelige Meddelelser* a few years ago Prof. Œrsted very fully worked out and displayed the high systematic importance of the form of the styles and stigmas in *Quercus* and the other *Cupuliferæ.* To the same publication, for the year 1869, he has contributed a brief article on the same subject in relation to the Californian Holly Oak (*Quercus agrifolia*), in Danish, of which at the close of the volume he has kindly given a French translation. He shows that this oak, with the port of *Q. Ilex*, has the styles and calyx as well as the ovules of the mainly Asiatic subgenus *Erythrobalanus*, in which he forms for it a separate section.

To the volume for 1870, Œrsted contributes an analogous note upon *Juglandeæ*, in which, by the way, he points out the fact that *Pterocarya* differs from *Juglans* and *Carya* in having foliaceous four-parted cotyledons which rise out of ground in germination; and he proceeds to show that his *Oreonumoa*, from Central America, which in the Prodromus had been made a section of the Asiatic genus *Engelhardtia*, is remarkably distinguished by its styles and less so by its embryo. Both papers conclude with remarks upon the geographical distribution of these genera, etc., as related to recent geological changes. Noting that *Juglans, Carya*, and *Engelhardtia* were all three well represented in Europe during the Miocene period, he infers that America was thence supplied with *Juglans* and *Carya* by way of the west, and with the representative of *Engelhardtia* by the east. We think that all the known facts conspire to show that both came by the east and north. In the structure of the styles of *Quercus agrifolia* Œrsted detects an oriental origin; and he speculates suggestively upon the Asiatic elements in the Californian flora (which we think are few) and upon what he calls its insular character, meaning by this, probably, only its marked distinction from the eastern N. American flora. And he appears to attribute this to the Sierra Nevada, which he terms the *maritime* Alps of California. But a different and more efficient way of separation may readily be suggested. A. G.

## III. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Meteorological Observations on Mt. Washington.*—The meteorological observatory, as it may be called, on Mt. Washington, which Prof. C. HITCHCOCK, the head of the Geological Survey of New Hampshire, and Prof. J. H. HUNTINGTON have been the means of establishing, has for its observers Prof. Huntington, Mr. S. A. Nelson of Georgetown, Mass., and Sergeant Theodore Smith. The latter is also telegrapher, and was appointed to the station by General Myer, head of the "Bureau of Telegrams and Reports for the Benefit of Commerce," recently established by Congress. In addition, Messrs. A. F. Clough and H. A. Kimball are the photographers. Prof. C. H. Hitchcock, at Hanover, has telegraphic connection with the summit, and occasionally joins the observers.

Gen. Myer ordered the laying of the telegraphic wire to the summit, so that a daily statement of the observations might be sent to Washington and to the rest of the country. The house occupied by the observers is the depot of the Mt. Washington railroad. The party has two barometers, thermometers, a hydrometer, Robinson's self-registering anemometer, and an anemoscope. Three daily telegraphic reports are sent out, two to the Bureau of Telegrams at Washington, and one to the New England Associated Press, Boston. The party give their time and labor without remuneration. The expenses, apart from those of the agent of the Bureau of Telegrams, have been assumed by Prof. Hitchcock, he depending on the public for its return. He states in a letter dated December 31st, that two hundred dollars more are needed to carry them through the season. Part of the expenses come from the necessity of keeping a watch for the telegraph wire in the windy region between Littlefield and the mountains.

2. *Unusual exhibition of halos.*—On the morning of Dec. 21, 1870, there was observed at Galesburg, Illinois, an unusual exhibition of halos. The phenomenon began when the sun rose, and continued till nearly noon, though after ten o'clock nothing was seen but the common halo of 22° radius. About 45 minutes after sunrise, there was seen the halo of 22° radius; that of 46° radius; a parhelic circle through the sun, parallel to the horizon; two parhelia on each side of the sun near the intersection of the parhelic circle with the two halos; a contact arch near the highest point of each of the halos; and a vertical column passing through the sun. All these phenomena are represented by figures in Loomis's Treatise on Meteorology, pages 216–219. Besides these appearances there were also noticed lines of illumination nearly vertical, but somewhat concave toward the sun, about five or six degrees in length, touching the circle of 46° radius at the points where it was intersected by the parhelic circle. These arcs are of unusual occurrence. They are, however, noticed by Prof. Bravais in his Memoir on Halos in the Journal de l'Ecole Polytechnique, t. 18, p. 112.

The temperature at the time of these halos was about zero, and the air was full of frost, driven sometimes in light clouds before a brisk N.W. breeze. For the above information we are indebted to a letter from Prof. M. L. Comstock of Knox College.

3. *Head Waters of the Amazon.—Observations on the Geography and Archæology of Peru;* by E. G. Squier. 28 pp. 8vo. (Read before the Amer. Geogr. Soc., Feb., 1870).—In the course of this interesting Memoir, Mr. Squier discusses the question whether the river Marañon or the Ucayali, (the two rivers which unite to form the Amazon), should be considered the main head of the Amazon. He observes that the Ucayali exceeds the Marañon by several hundreds of miles, whether its longest branch be the Urubamba or Vilcamayo rising at the lake of La Raza, or the Apurimac rising in the department of Arequipa. As regards volume, he cites Dr. Tavara, a member of the Hydrographic Commission of 1868, under the Peruvian government, who says

that the Marañon both in length and volume is inferior to the Ucayali, and it therefore "leaves the latter to bear without dispute the title of Rio Madre del Amazonas." The Ucayali is navigable from the junction of the two rivers, the Urubamba (or Vilcamayo) and the Tambo which join to form it, down to the Amazon, a distance of 772 miles; and the Urubamba is navigable for small vessels for 2:6 miles, or 220 miles from Cuzco, the capital of the most populous department of Peru, and that with which communication with the Amazon would be of the highest importance.

4. *Solar Eclipse.*—No information has yet been received (Jan. 16th) with regard to the observations on the recent solar eclipse beyond the general intelligence that the observers had good weather in Spain, and only moderately good in Sicily; and the fact that the Psyche, having the Sicilian party from England on board, foundered on a sunken rock off Catania, but without loss of hands or of scientific instruments.

5. *Murchison* was disabled near the close of November by a stroke of paralysis. According to the latest reports he will soon be at work again.

6. *Prof. Balfour Stewart* was among the sufferers by the collision on the London and Northwestern Railway, on the 26th of November. He is reported as gaining as rapidly as could be expected, considering the nature of his injuries.

### OBITUARY.

G. BISCHOF, the author of the great work on Chemical Geology and of various researches on related subjects, died early in Dember last, at Bonn.

Wm. CHAUVENET, author of several mathematical works of high merit, and for some years Chancellor of the University of St. Louis, died at St. Paul, Minn., Dec. 13, 1870, aged 51.

## IV. MISCELLANEOUS BIBLIOGRAPHY.

1. *The Journal of the Franklin Institute.* Editors, Drs. MORTON and WAHL. Philadelphia, Pa.—Our esteemed contemporary enters with its current number upon its 46th year; and we are pleased to learn, with every prospect for prosperity and continued usefulness.

Devoted strictly to Mechanical and Physical Science, it has long and ably held an honored position among American journals and is the favorite organ of our practical scientists.

As the written tradition of the oldest Mechanics' Institute in America, it is well entitled, by this time, to wear grey hairs,—yet no such grave characteristics are visible to us; and if it is literally to "renew its youth" for another half century, the hands in which we now find it are well qualified to inaugurate the happy era.

2. *The Malay Archipelago: the Land of the Orang-utan and the Bird of Paradise. A Narrative of Travel, with Studies of Man and Nature;* by ALFRED RUSSELL WALLACE, author of "Travels on the Amazon and Rio Negro." "Palm Trees of the Amazon," etc. 638 pp. 12mo. New York, 1869. (Haperr &

Bros.)—Although it is over a year since this work was published, it deserves mention here. Mr. Wallace's explorations were undertaken for the purpose of collecting specimens in Natural History. His work gives much interesting information on the customs of the people he visited, but is chiefly important to science, on account of its notes on the habits, peculiarities and geographical distribution of the animal and vegetable life of the various islands. As the idea of "Natural selection" had already come to him, he aims to point out the bearings of the various facts on the question of variation, and thereby on the origin of species. All will not accept his conclusions, which seem sometimes forced, but they cannot fail to read with interest and profit the results of his observations, although given with an excess of personal detail. The volume contains a map of the East Indies, and many excellent illustrations.

3. *Adventures of a Young Naturalist;* by L. Biart, edited and adapted by Parker Gillmore, author of "All Round the World," etc. 492 pp. 12mo, with 117 illustrations. New York, 1871, (Harper & Brothers.)--Our School system will not be complete in its arrangement of studies until children are made to enter upon some simple course in Natural History—teaching them how and what to see in this objective world,—from the time they are ten or eleven years of age. It is well for them, that while the schools are thus defective, they are partly supplied with the means of such instruction in the "Young" literature of the day; and one of the best books for the purpose is the Adventures of a Young Naturalist. The region of these adventures was Mexico. Facts about its prominent trees, flowers, and animal life, and the physical phenomena that appear by the way are introduced as a part of the adventures, and usually in a manner that adds interest to the story. The volume is illustrated by a multitude of engravings, which exhibit, with wonderful exactness and artistic effect, the forest scenes of the tropics. We should like to change the page on aërolites and some other paragraphs. But in general the book is well suited to its purpose.

4. *The Rob Roy on the Jordan, Nile, Red Sea, etc.;* by J. Macgregor. 464 pp. 12mo, with maps and illustrations. New York, 18'0. (Harper & Brothers).—This admirable book of canoe travel by a man of resource and culture, and of sympathy with all that is good and beautiful, is not without special scientific interest, as it contains excellent descriptions of natural scenery of rivers and mountains, treats of the present distribution of the crocodile of the Nile, and gives the first account published of the head-waters of the Jordan. [2, 3, 4 are originally English publications.]

United States Geological Exploration of the Fortieth Parallel: Clarence King, Geologist in charge. Vol III. Mining Industry by James D. Hague, with geological contributions by Clarence King. 648 pp. 4to, illustrated by 37 plates and an accompanying Atlas of 14 colored Imperial folio plates. Washington, (Government Printing Office.) 1870.

Report on the Geological Survey of the State of Iowa, made to the thirtieth General Assembly, Jan. 7, 1870, containing results of examinations and observations made within the years 1866-1869; by Charles A. White M.D. Vol. I. 392 pp. royal 8vo with maps, views, and sections. Des Moines, 1870. Geological Corps, C. A. White, State Geologist, O. H. St. John, Assistant, R. Emery, Chemist.

# APPENDIX.

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*Letter to the Editors from* Prof. B. A. Gould, *dated Cordoba (Cordova), November* 9, 1870.

I will begin to-day to fulfil my promise of writing to you from time to time of the progress of our Argentine Observatory, or rather of the preparations for its organization.

Leaving New York on the 28th of May, and arriving in England after 11 days, just six weeks were available for a hurried visit to London, Paris, and some of the German cities, where instruments were constructing, or books were to be obtained. Fortunately all was then peaceful and happy, and the sudden outburst of war did not take place until we were in England again, and on the point of re-embarkation. The greatest interest and sympathy were manifested by all the astronomers whom I met; and many of them gave expression to their good-will in a very practical and tangible manner, by gifts of serviceable books and by essential assistance.

On July 20, we left Liverpool in a steamship bearing the auspicious name of "Tycho Brahe," and landed on August 23d in Buenos Aires, where the cordiality of our reception could scarcely be surpassed. The officers of the National Government have afforded every courtesy and assistance possible, while the citizens seem to feel a sincere and most intelligent interest in our undertaking, and have extended to us a most friendly and gratifying welcome. Only two or three days previous to my arrival, an appropriation had been passed by the National Congress for the acquisition of additional instruments and books; but on a subsequent reconsideration a further amount was added for the purpose of completing and extending the building, which had been but partially provided for.

While crossing the tropics, I was much impressed by the luminosity of the background of the heavens, by night. This afforded a light not inferior to that of the sky when the moon is at her quarter,—reducing the apparent brilliancy of the stars, and often rendering it difficult to recognize the outline of prominent constellations. I have an indistinct remembrance of reading some similar remark, in Humboldt's personal narrative, I think; but of course I have here no means of refreshing my memory. This brightness was not dissimilar to that of the interior of an auroral arch. Can it be that this phenomenon stands in some relation to zodiacal light? That this latter is a terrestrial appendage and not a solar one, I have long regarded as demonstrated. This atmospheric or superatmospheric brightness first attracted my attention when we had reached the latitude of 30° N., and was much fainter soon after we had crossed the equator. The lenticular outline of the zodiacal light was not visible in the west after sunset on these occasions; indeed, the general brightness of the sky was quite as great as I have ever seen that of the zodiacal light itself.

My own family reached Cordoba on the night of September 8, and I lost no time in selecting a site for the Observatory. The

Provincial Government undertook to purchase and present to the Observatory a piece of land 250 varas (216·9$^{m}$) square, and within four days the position was chosen and the preliminary steps were taken for the acquisition of the ground. At present the foundations, both for the buildings and the piers of the instruments, are essentially completed, and there is no doubt in my own mind that the mason work for the whole building will be completed at the close of November.

Cordoba is situated only about ten miles east of the base of the Sierra, and occupies an eroded basin, about 1¼ miles in width, along the north side of which runs the Rio Primero, which, rising in the Sierra, discharges its waters into a salt lake some eighty miles farther eastward. It is so easily fordable, except in the rainy season, that no bridge has been constructed across it until this present month, but an iron one has now been erected by the National Government. The valley of the river, which is here expanded into a basin, although much contracted both above and below the town, is bounded by walls of sandy clay, or rather by what would be walls were it not for their very broken and irregular outline, caused by the wash of the torrents, which pour down into the hollow after every rain, leaving ravines or gullies of from ten to forty feet deep, which extend far into the plain above,—forming a miniature coast indented by fiords, like the shores of Norway and Scotland. The city itself rests on a bed of firm granitic sand, which drifts with the wind; but the dustiness of the unwatered plains of fine powdered clay on the pampa above cannot be described. The *barranca*, or bank, varies in height from eight to twenty-six meters, and the land then rises with a gentle slope southward to the divide between the rivers Primero and Segundo, and northward similarly for a considerable distance. At a distance of two miles from the city, north or south, only the summits of the many church-towers are visible, springing apparently out of the ground. The elevation of the town above the sea-level is variously stated, but cannot be far from four hundred meters; the whole pampa having a slight inclination from the mountains to the sea.

Of course it was out of the question to place the Observatory in the hollow, for want of a proper horizon, as well as on account of the numerous obstructions from houses or trees. Upon the barranca, a better foundation is likewise afforded upon the *tosca*, or hard clay, which alternates with sand in successive strata. The disadvantages consist in the distance from other dwellings, and in the total want of water, which can only be obtained from the river, or from wells of some seventy meters or more in depth;—while the impalpable and all pervading dust will inevitably render the instruments valueless, unless an abundant vegetation be maintained in the immediate vicinity of the building. For this, means will doubtless be provided in some way, inasmuch as the Minister, and all the officers of Government who have to do with the affairs of the Observatory, are evidently anxious to do every thing in their power to promote its success.

The four assistants arrived Sept. 26, and on Oct. 17, came the rst instalments of material for the building. The plans had been xcellently worked out by Messrs. Harris and Ryder of Boston, who had also superintended the construction of those portions which consist of iron,—such as the roof, floors, stairways, revolving dome, and machinery for opening and closing the shutters,—all in a manner which reflects on them the highest credit. But to my eep regret and mortification, the carpentry had been shipped in uch an improper manner, and the bills of lading so loosely made out, that the materials have arrived in an unsatisfactory state; much being missing and more badly broken, while we have no egal hold on the ship. When the parts are assorted for putting ogether, which will probably be in a month, I hope the state of affairs will prove better than present indications promise.

The small portable transit instrument of the Coast Survey has been in use for the past week under a little hut of bricks and mud constructed for the purpose, and the Smithsonian zenith-telescope s just put in place. From such means of judgment as I have yet obtained, I suppose the geographical position to be not far from 31° 24′ 40″ south latitude and $0^h\ 52^m\ 34''$ east from Washington.

The meteorological relations of this region are evidently very peculiar, and I deeply regret my want of apparatus for their proper investigation without trenching upon the means and energies requisite for our legitimate astronomical work. In Buenos Aires the winter is a rainy season, while the summers are dry. Here, at a distance of 500 miles, the reverse holds good; the winters being absolutely rainless, but the summers subject to frequent and very violent rains. A sharp shower of half an hour on Sept. 29th, was the first rain of the season, none having fallen up to that time since the beginning of May. Now we have a shower every three or four days, always violent and copious, but not generally continuing for more than an hour. Later in the summer we are told that they will be yet more .impetuous and of longer duration; but a continued storm of half a day or more is said to be unknown here. Thunder and lighting are the unfailing attendants of these rains, and I have never seen more splendid exhibitions of atmospheric electricity than have accompanied every one of the eight or ten which have occurred during the past month. The volume of water which falls on these occasions is immense. The river often rises many feet in a single hour, receding afterward nearly as rapidly. Part of the town is traversed by what is called the cañada, the bed of a water-course some 6 or 7 meters in breadth, which discharges into the river, and is bordered by steep banks until it reaches the basin in which the town is situated. This is usually dry, in fact I have never seen it otherwise, although I am residing within 50 yards of it, and cross it many times a day. But during, and immediately after, one of these violent rains, it becomes the channel of a torrent, and has been known to rise to the height of 4 meters in two hours. It is fed by no spring, and merely brings down the surface drainage of a few miles of pampa; yet but for a strong dike built by the Jesuits in 1671, the city would be subject to severe inundations. Indeed a flood from this cañada did destroy a large part of the town in 1623. The whole line of the barranca is intersected by ravines similar in character to this cañada, and it is these which produce the broken jagged outline of which I have spoken. I have found it impossible to select a fitting place for the observatory, where the grounds could be unbroken by these gullies, and care will be needful to prevent the descent to a lower level of much of the soil which has been given us.

The wind is very rarely from the east, and I am informed that it has never been known to be due west; a circumstance doubtless attributable in great part to the barrier presented by the magnificent Sierra west of the city. The winters are very chilly, even snow being not infrequent, although ice does not form. Even now while roses, cactuses, cassias and white lilies are in full bloom, the young peaches of half their full size, and the grapes well formed, —the mornings are uncomfortably chilly, and no one thinks of wearing other clothes than woolen. Yet before the sun is an hour high, and until he has gone down in the west, his beams are simply intolerable. The foreigner who goes about or exercises in the sunshine between 12 and 2, is sure to rue it, and the natives never commit such an indiscretion. The astronomer, whose exposure is by night, finds himself for once at a vantage in the fiery Argentine summer. Yet the air is not so hot as the torrid climate would suggest; and the nights even in midsummer are cool.

The dryness of the air has impressed me quite as much as any other climatic peculiarity. A bowl of water left uncovered in the morning is dry at night; ink vanishes from the inkstand and becomes thick almost by magic; the bodies of animals, left exposed, dry up instead of decomposing; and at other times than during, or immediately after a rain, neither active exercise nor exposure to the sun's rays cause a perceptible perspiration.

We are suffering no small embarrassment from the non-arrival of our books and instruments from Germany. The Meridian circle, clocks, chronometer, photometer, etc., were all on board ship at Hamburg, when the war was declared, and up to the last advices, although the blockade of the Elbe had been raised, no vessel for the River La Plata had ventured to leave port. Should another month pass without their arrival it would be a serious drawback to us. Meantime there is plenty of work to be done in superintending the building, and making the numerous preliminary calculations for places of standard stars, tables of reduction, etc. Should the meridian-circle be long delayed, the time might be well employed in making such a Uranometry for the southern sky as the absence of a photometer will allow,—on the same plan as Argelander's, and as my unpublished northern one, made at Albany in 1858.

The temporary embarrassments of the Government-treasury, occasioned by the serious and destructive insurrection in Entre Rios, may slightly retard our progress, or at least render it less easy for the necessary means to be provided, especially since the carpentry has arrived in so unfortunate a condition; but that cordial desire to facilitate our work, which clearly animates all parties here, will doubtless reduce difficulties of this sort to a minimum while they continue, and render their duration as brief as may be.

## POSTSCRIPT.—*Solar Eclipse of December* 22*nd.*

Through the kindness of Prof. J. E. HILGARD, Assistant in Charge, J. S. Coast Survey, Washington, we are enabled to publish the ollowing extracts from two letters, giving information respecting he observations on the Eclipse made in Sicily.' Other extracts ollow from letters published in the New York daily papers.

*From letter of* General E. ABBOT *to Prof. J. E. Hilgard, dated t sea, Jan.* 17, 1871.—From our party in Spain I have heard nothng. In Sicily we had hard luck, but got some good observations, otwithstanding. The expedition was divided into five parties. t *Catania* were the photographers, with Mr. Schott and Prof. ane. Clouds prevented observations of the corona. At a villa in he environs of the town, were Prof. P. and his two sons and Mrs. .; they had good luck, the clouds opening just so that they could bserve the corona. They got good sketches and good polariscope bservations. At *Monte Rossi* (3000 feet altitude) Prof. Peters ailed from clouds. At *Carlentini* (on contact line south of Cataia), Prof. Watson got very valuable observations on the corona. n Etna (8400 feet altitude) Gen. Abbot failed from clouds. So wo-fifths of our party succeeded, and in combination with similar artial observations of the English, &c. parties, we have settled hat the corona is, in part at least, solar. The light is strongly olarized in radial planes. The spectroscope failed except a partial bservation by the English, which goes to confirm last year's obervations in America.

*From a letter from* Prof. PEIRCE, *dated at Catania, Dec.* 22, 870, *and published in the Boston Advertiser.—Half-past four.*— Vell, the eclipse is over, and, wonderful to relate, all the success eems to have been reserved for our party. Mr. —— has got admiable results with his polariscope; —— and —— have made valuble sketches of the corona, and all the large party assembled at he villa were delighted with the whole phenomenon, to which the pithet of *magnifique* was applied on all sides. And you would ike to know how it was that there was so great success with us, nd not with the others. Well, it was thus: early in the morng all was bright and fair, but as the day advanced clouds began o appear, which increased greatly with the cold, arising from the liminished action of the sun upon the earth. These clouds kept rowing with a rising wind till nearly at the middle of the eclipse, he sun was hidden behind a thick, black screen, and all hopes of urther view of it deserted us. But just previously to the instant f total obscuration there was a break in the clouds, which was he more remarkable because it was raining and hailing at the ime. This break did not extend a thousand feet from the place here we observed. But it gave us a superb view of the corona nd the whole totality, and enabled us to establish very important onclusions. It must be said, however, that there was just enough aze to deprive us of what I am disposed to call the false corona, nd which I consider to be a part of our own atmosphere. But he true solar corona is clearly proved to be a solar atmosphere exending about eight [eighty ?] thousand miles above the ordinarily isible surface of the sun. There were three different sources of roof of this conclusion. The work is done successfully.

*Observations by Prof.* HARKNESS *and others*, (N.Y. Times, Jan. 4.)—*Prof. Harkness, who was in Sicily, and Mr. Burton, at Agosta,* state that in their spectroscopic observations, the ordinary spectrum of the chromosphere and hydrogen flames was seen, and outside of the part of the spectrum due to the chromosphere, there was a *clear green line.* As to the nature of the green line they have only the fact that the lines were not those of hydrogen, or of iron, or of any known terrestrial substance.

It is further stated that the corona, according to an observer (name not mentioned), is strongly polarized, and hence shines by reflected light; and it is polarized in such a way as to prove that it is not atmospheric; and hence, it is added, it may be considered as a solar appendage reflecting in an eclipse the light of the obscured sun. Prof. Watson asserts that he has seen a part of the corona float away "like a vail," which suggests that its matter is constantly dispersing.

*Observations of Prof. C. A. Young, Jerez, Spain,* (Tribune, Jan. 25th).—The sun was obscured until totality, and just then a small rift in the heavy clouds opened the sun to view, and gave an opportunity for excellent observations. One good photograph of the corona was obtained. Prof. Young writes as follows:

Our spectroscopic results completely confirm those of last year, except that the two faint lines, which I saw between D and E last year and suspected to be corona lines as well as 1474, were not seen at all this time; 1474 was traced by Prof. Winlock to a distance of nearly 20′ from the sun's limb. I traced it 16′ on the West, 12′ on the North, 14′ on the East, and about 10′ on the South. The principal chromosphere lines were also visible in the corona to a distance of 3′ or 4′. Prof. Winlock and myself both agree in attributing this to the reflection of the haze around the sun. I am more confident as to this, because last year, in a clear atmosphere, the C line was certainly sharply terminated at the upper limit of the chromosphere or prominences under observation.

But the most interesting spectroscopic observation of the eclipse appears to me to be the ascertaining at the base of the chromosphere, and, of course, in immediate contact with the photosphere, of a thin layer in whose spectrum the dark lines of the ordinary solar spectrum are all reversed. Just previous to totality, I had carefully adjusted the slit tangential to the sun's limb at the point where the second contact would take place, and was watching the gradual brightening of 1474 and the magnesium lines. As the crescent grew narrower, I noticed a fading out, so to speak, of all the dark lines in the field of view, but was not at all prepared for the beautiful phenomenon which presented itself when the moon finally covered the whole photosphere. Then the whole field was at once filled with brilliant lines, which suddenly flashed into brightness and then gradually faded away until, in less than two seconds, nothing remained but the lines I had been watching. The slit was very close, and the definition perfect.

Of course I cannot positively assert that all the bright lines held exactly the same position that had been occupied by dark ones previously, but I feel very sure of it, as I particularly noticed several groups, and the whole arrangement and relative intensity struck me as perfectly familiar.

This observation is a confirmation of Secchi's continuous spectrum at the edge of the sun, and I think tends to make tenable the original theory of Kirchoff as to the constitution of the sun and the origin of the dark lines in the ordinary solar spectrum.

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## Art. XXIV.—*On the Discovery of actual Glaciers on the Mountains of the Pacific Slope;* by Clarence King, U. S. Geologist.

Western explorers have usually confined their labors to the more accessible altitudes; indeed it is only within the last ten years that the higher portions of the great West have been studied. One remarkable feature of the extreme elevations is the absence of glaciers. Wide areas of mountains whose average altitude and configuration are equivalent to the glacier-bearing mountains of Switzerland have been found to be covered here and there by deep fields of perpetual snow, similar in character to the *névé* of the Alps. The whole topography of the loftier Cordillera within the United States has been modified by glaciers now extinct: vast moraines flank the higher gorges; accumulations of gravels and sands, erratics, *roches montonnées*, and the finest possible instances of polished rock abound wherever a considerable mountain mass is lifted above nine thousand feet. It is almost startling to observe the freshness of these indications. Travel where one will in the high Sierras or in the more elevated regions of the Rocky Mountains, he seems to be treading the pathway of a glacier of yesterday. A future study will, without doubt, clear up the entire chronological relations of the ice occupation of these ranges. The studies of Professor Whitney and his corps in the heights of the Sierra Nevada have developed a series of extinct glaciers equaling in all respects the former grandeur of the Alpine system; yet with the exception of one or two rudimentary masses of ice, nothing is left in the Sierras but the fields of perpetual *névé* snow. Very remarkable in depth and area as these are, they are not sufficiently extended, nor is there enough winter accumulation of snow, to start a glacier movement. Singularly too, the heights of Colorado prove to be even less snowy than the Sierras. The *névé* masses are less, and they waste much more during the dry season. The Wind River, Wahsatch and Uintah ranges have been examined by the writer, and although the extent of lofty peaks is very great, they are even less snowy than the heights of the Laramie range in Colorado. A comparison of the average annual temperatures of the Cordillera north of latitude 36° clearly shows that the climate is not too warm for the existence of glacier masses, and that the small precipitation of snow is due chiefly to the lack of moisture in the air. This entire region is swept by an almost invariable west wind, whose lower strata have been deprived of their moisture by the warm ascending currents of the valleys, and, although the peaks of the mountains are lifted into this wind, the actual amount of moisture is too small to create a great piling up of *névé*. Accordingly the summit region is characterized by the absence of glaciers and a tendency of the entire flora to ascend into higher altitudes than at corresponding Alpine stations. A single point lifted to a great height is not sufficient to form a great condenser. A widely elevated region is necessary for the creation of great local storm systems; the two parts of the Cordillera, therefore, where we should most naturally look for glaciers are the Mount Whitney region in the Sierras of California, and the high group west of Denver. Professor Whitney, in his description of the former, calls particular attention to their absence. The writer was one of those who made the exploration of this region, and was as much impressed as any one with this remarkable lack.

In early September, 1870, with a small detachment of "the U. S. Geological Exploration of the 40th Parallel," acting under the orders of Maj. Gen. Humphreys, I visited Mount Shasta in northern California, for the purpose of making a detailed survey of the lava systems which flow eastward from that peak, and connect themselves with the basalt regions of the Nevada Desert. On September 11th, we climbed to the top of the lesser Shasta, a conical secondary crater jutting out from the main mass of the mountain on its northwest side. The party consisted of Mr. S. F. Emmons, Mr. F. A. Clark, Mr. A. B. Clark, and Mr. Sisson, the well-known mountaineer and guide of the region, and the writer. We carried our physical and topographical instruments, our fur beds, and provisions for four days. In the afternoon at about half past one o'clock we reached the rim of the cone, and looked down into a deep gorge lying between the secondary crater and the main mass of

Shasta, and saw directly beneath us a fine glacier, which started almost at the very crest of the main mountain, flowing toward us, and curving around the circular base of our cone. Its entire length in view was not less than three miles, its width opposite our station about four thousand feet, the surface here and there terribly broken in "cascades," and presenting all the characteristic features of similar glaciers elsewhere. The region of the terminal moraine was more extended than is usual in the Alps. The piles of rubbish superimposed upon the end of the ice indicated a much greater thickness of the glacier in former days. After finishing our observations upon the side crater, and spending a night upon the sharp edge of its rim, on the following morning we climbed over the divide to the main cone, and up to the extreme summit of Shasta, a point 14,440 feet above the sea level. From the crest I walked out to the northern edge of a prominent spur, and looked down upon the system of three considerable glaciers, the largest about four and a half miles in length, and two to three miles wide. On the next day we descended upon the *south* side of the cone, following the ordinary track by which earlier parties have made the climb. From the moment we left the summit we encountered less and less snow, and at no part of the journey were able to see a glacier. An east-and-west line divides the mountain into glacier-bearing and non-glacier-bearing halves. The ascent was formerly always made upon the south side where, as stated, there are no glaciers, and this is why able scientific observers like Professor Whitney and his party should have scaled the mountain without discovering their existence.

Before and after the ascent of Mount Shasta, a week was given to an examination of the southern half of the volcano. Since the earliest settlement of Strawberry and Shasta valleys, there has never been such a complete denudation. From June to November, the snow masses were less than they have ever been seen before. This favored very greatly our geological observations, and gave us an excellent opportunity to study the relics of the former great *névé*. We explored one after another all the cañons which, approximately following the radius of the cone, are carved to a greater or less depth into the lava-flows. From the secondary cone around to the eastern side of the main mass are only occasional fields of snow and ice—bodies of a thousand or two feet long, usually quite narrow and lying on the more shaded sides of the ravines. In nature and texture they are quite similar to the true glacier ice, possessing in all cases planes of stratification which indicate the pressure of the formerly overlying masses. There is little doubt that all the scattered snowfields, that, in the months of August and September, dapple the southern slopes, are the relics of glaciers. They are found in the region of the ancient *névé*, but extending downward into what was formerly the zone of movement.

Upon reaching the eastern side we found in a deep cañon a considerable glacier, having its origin in a broad *névé* which reaches to the very summit of the peak. The entire angle of this glacier can be hardly less than 28°. It is one series of cascades, the whole front of the ice being crevassed in the most interesting manner. Near the lower end, divided by a boss of lava, it forks into two distinct bodies, one ending in an abrupt rounded face no less than nine hundred feet in height. Below this the other branch extends down the cañon for a mile and a half, covered throughout almost this entire length with loads of stones which are constantly falling in showers from the cañon walls on either side. Indeed for a full mile the ice is only visible in occasional spots where cavities have been melted into its body and loads of stones have fallen in. From an archway under the end a considerable stream flows out, milky, like the water of the Swiss glacier streams, with suspended sand. Following around the eastern base of Shasta, we made our camps near the upper region of vegetation, where the forest and perpetual snow touch each other. A third glacier of somewhat greater extent than the one just described, was found upon the northeast slope of the mountain, and upon the north slope, one of much greater dimensions. The exploration of this latter proved of very great interest in more ways than one. Receiving the snows of the entire north slope of the cone, it falls in a great field, covering the slope of the mountain for a breadth of about three or four miles, reaching down the cañons between four and five miles, its lower edge dividing into a number of lesser ice-streams which occupy the beds of the cañons. This mass is sufficiently large to partake of the convexity of the cone, and, judging from the depth of the cañons upon the south and southeast slopes of the mountain, the thickness cannot be less than from eighteen to twenty-five hundred feet. It is crevassed in a series of immense chasms, some of them two thousand feet long by thirty and even fifty feet wide. In one or two places the whole surface is broken with concentric systems of fissures, and these are invaded by a set of radial breaks which shatter the ice into a confusion of immense blocks. Snow bridges similar to those in the Swiss glaciers are the only means of crossing these chasms, and lend a spice of danger to the whole examination. The region of the terminal moraines is quite unlike that of the Alps, a larger portion of the glacier itself being covered by loads of angular débris. The whole north face of the mountain is one great body of ice, interrupted by a few sharp lava ridges which project above its general level. The veins of blue ice, the planes of stratification, were distinctly observed, but neither *moulins* nor regular dirt-bands are present. Numerous streams, however, flow over the surface of the ice, but they happen to pour into crevasses which are at present quite wide.

One of the most interesting of all the features of the country was, however, the clearly defined moraines of the ancient and more widely extended glacier system. Nearly the whole topography of the lower part of the cone is modified by the deposition of glacial material. At an elevation of about eight thousand feet upon the southern or snowless side of the mountain, is a great plateau-like terrace, about twenty-five hundred or three thousand feet wide, extending around one half of the cone and composed wholly of moraine material. Besides these, long, straight, or slightly curved medial moraines jut from the mountain in all directions, not unfrequently descending into the valley for several miles. Our party spent six weeks in climbing all over the cone, studying the systems of lava flows, laying down the sheets of material as they are exposed upon the flanks and cañons of the snowless parts of the mountain; and in making a detailed examination of the glaciers, and a complete survey of the cone and valleys about its base. A large number of altitudes were determined, and the material gotten by my assistant, Mr. F. A. Clark, for a topographical map of the mountain and glaciers, on a scale of two inches to the mile, and with grade curves of two hundred feet vertical intervals. When this map is completed, and the accurate form and dimensions of the glaciers determined, it is my purpose to present a careful account of the past and present conditions of the great volcano.

During the prosecution of this work, Mr. Arnold Hague, assistant in the survey, was engaged upon Mount Hood, carrying out the same system of work, the topography being executed by Mr. A. D. Wilson. The system of volcanic flows, and the existing and extinct glaciers of Hood, were worked out in the same manner as I have done for Shasta, and the results will form a part of our Report.

Later, Mr. S. F. Emmons, accompanied also by Mr. Wilson, with very great difficulty pushed through the forest to Mt. Rainier, and laid the foundation of a similar survey of that cone. His descriptions of the peak and its glaciers will form a most interesting chapter of our work upon the volcanoes.

The following letters addressed to me by Mr. Emmons and Mr. Hague contain an account of their glacier discoveries.

**To Clarence King, U. S. Geologist:—**

The glaciers of Mt. Tachoma, or Rainier as it is more commonly called, form the principal sources of four important rivers of Washington Territory, viz: the Cowlitz, which flows into the Columbia, and the Nisqually, Puyallup and White rivers which empty into Puget Sound. In accordance with your instructions, Mr. A. D. Wilson and I visited this mountain in the early part of October, 1870, and carried the work of making its complete survey, both geological and topographical, as far as the lateness of the season and the means at our disposal would permit. As the topographical work has not yet been plotted, the figures given in my notes are merely estimates, and liable to subsequent correction. I herewith transmit an abstract from my notes upon the glaciers, embracing those of rather more than half the slopes of the mountain, those on the eastern side, from the extreme southern to the extreme northern point.

The summit of Tachoma is formed by three peaks, a southern, an eastern, and a northwestern: of these the eastern is the highest; those on the south and northwest, being apparently a few hundred feet lower, are distant about a mile and a half to two miles from this, and separated by deep valleys. The eastern peak, which would seem to have formed originally the middle of the mountain mass, is a crater about a quarter of a mile in diameter of very perfect circular form. Its sides are bare for about 60 feet from the rim, below which they are covered by a *névé* having a slope of from 28° to 31°. This *névé* extending from the shoulders of the southwestern peak to those of the northern, a width of several miles, descends to a vertical distance of about 2000 feet below the crater rim, an immense sheet of white granular ice, having the general form of the mountain surface, and broken only by long transverse crevasses, one of those observed being from one to two miles in length: it is then divided up by the several jutting rock-masses or shoulder of the mountain into the Nisqually, Cowlitz and White River glaciers, falling in distinct ice cascades for about 3000 feet at very steep angles, which sometimes approach the perpendicular. From the foot of these cascades flow the glaciers proper, at a more gentle angle, growing narrower and sinking deeper into the mountain as they descend. From the intervening spurs, which slope even more gradually, they receive many tributary glaciers, while some of these secondary glaciers form independent streams, which only join the main river many miles below the end of the glaciers.

The Nisqually, the narrowest of the three main glaciers above mentioned, has the most sinuous course, varying in direction from southwest to south, while its lower extremity is somewhat west of south of the main peak: it receives most of its tributaries from the spur to the east, and has a comparatively regular slope in its whole length below the cascades. There are some indications of dirt-bands on its surface, when seen from a considerable elevation. Toward its lower end it is very much broken up by transverse and longitudinal crevasses: this is due to the fact, that it has here cut through the more yielding strata of volcanic rock, and come upon an underlying and unconformable mass of syenite. The ice front at its base is about 500 feet in height, and the walls of lava which bound its sides, rise from 1000 to 1500 feet above the surface of the ice, generally in sheer precipices.

The bed of the Cowlitz glacier is generally parallel to that of the Nisqually, though its curves are less marked: the ice cascades in which each originates, fall on either side of a black cliff of bedded lava and breccia scarcely a thousand feet in horizontal thickness, while the mouths of the glaciers, if I may be allowed the expression, are about three miles apart. From the jutting edge of this cliff hang enormous icicles from 75 to 100 feet in length. The slope of this glacier is less regular, being broken by subordinate ice cascades. Like the Nisqually its lower extremity stretches out as it were into the forest, the slopes on either side, where not too steep, being covered with the mountain fir (*Picea nobilis*) for several hundred feet above the level of the ice, while the *Pinus flexilis* grows at least 2000 feet higher than the mouth of the glacier.

The general course of this glacier is south, but at its extremity it bends to the eastward, apparently deflected from its course by a cliff of older felsitic rock, more resisting than the lava. The consequence of this deflection is a predominance of longitudinal over transverse crevasses at this point, and an unusually large moraine at its western side, which rises several hundred feet above the surface of the glaciers, and partakes of the character of both lateral and terminal moraines: the main medial moraine of the glacier joins this near its lower end. This medial moraine proceeds from the cliff which bounds the ice cascade source of the glacier on the north, and brings down a dark porous lava which is only found high up on the mountain near the crater. The position of the medial moraine on the glacier would indicate that at least half its mass came from the spur on the east, which is probably the case.

This spur, comprehending the whole mass between the Cowlitz and White River glaciers, has the shape of a triangle whose apex is formed by a huge pinnacle of rock, which as its bedding indicates, once formed part of the crust of the mountain, but now stands isolated, a jagged peak rising about 3000 feet above the glaciers at its foot, so steep that neither ice nor snow rest upon it. One of the tributaries to the Cowlitz glacier from this spur brings down with it a second medial moraine, which is traceable to the mouth of the glacier, though in general these tributary glaciers bring no medial moraines.

On the eastern slopes of this spur between the two above named glaciers, spread secondary glaciers, frequently of great width, but owing to the limited height of their initial points, of inconsiderable length. These end generally in perpendicular cliffs overhanging the rocky amphitheaters at the heads of the smaller streams which flow eastward into the Cowlitz. Looking up from the bottom of one of these amphitheaters one sees a semi-circular wall of nearly 2000 feet of sheer rock, surmounted by about 500 feet of ice, from under which small streams of water issue, falling in silvery cascades on to the green bottom below.

A ridge of high jagged peaks connects this spur with the main range of the Cascade Mts. in the east, and forms the water-shed between the White and Cowlitz rivers. From the connecting saddle one can look northward across the brink of six glaciers, which all contribute to the White river; of these the first four come from the triangular spur already mentioned and are of comparatively little extent. The first two are, however, interesting from the vein structure which they exhibit; they both originate in an irregularly oblong basin, having the shape somewhat of an inclined ellipse, turning on its longer diameter, the outlets of the glacier being opposite the foci. Seen from a high point the veins form concentric lines generally parallel to the sides of the basin; the ends of those towards the center gradually bend round, until they join together in the form of a figure 8, and finally just above the outlets form two small ellipses. They thus constantly preserve a direction at right angles to that of the pressure exerted, downward by the movement of the ice mass, and upward by the resistance to this movement of the rock mass between the two outlets.

The main White River glacier, the grandest of the whole, pours straight down from the rim of the crater in a northeasterly direction, and pushes its extremity farther out into the valley than any of the others. Its greatest width on the steep slope of the mountain must be four or five miles, narrowing toward its extremity to about a mile and a half; its length can be scarcely less than ten miles. The great eroding power of glacial ice is strikingly illustrated in this glacier, which seems to have cut down and carried away on the northeastern side of the mountain, fully a third of its mass. The thickness of rock cut away as shown by the walls on either side, and the isolated peak at the head of the triangular spur, in which the bedding of the successive flows of lava, forming the original mountain crust, is very regular and conformable, may be roughly estimated at somewhat over a mile. Of the thickness of the ice of the glacier I have no data for making estimates, though it may probably be reckoned in thousands of feet.

It has two principal medial moraines, which, where crossed by us, formed little mountain ridges having peaks nearly 100 feet high. The sources of these moraines are cliffs on the steeper mountain slope, which seem mere black specks in the great white field above: between these are great cascades, and below immense transverse crevasses, which we had no time or means to visit. The surface water flows in rills and brooks, on the lower portion of the glacier, and *moulins* are of frequent occurrence. We visited one double *moulin* where two brooks poured into two circular wells, each about ten feet in diameter, joined together at the surface but separated below: we could not approach near enough the edge to see the bottom of either, but, as stones thrown in sent back no sound, judged they must be very deep.

This glacier forks near the foot of the steeper mountain slope, and sends off a branch to the northward, which forms a large stream flowing down to join the main stream fifteen or twenty miles below. Looking down on this from a high over-hanging peak, we could see, as it were, under our feet, a little lake of deep blue water, about an eighth of a mile in diameter, standing in the brown gravel-covered ice of the end of the glacier. On the back of the rocky spur, which divides these two glaciers, a secondary glacier has scooped out a basin-shaped bed, and sends down an ice stream, having all the characteristics of a true glacier, but its ice disappears several miles above the mouths of the large glaciers on either side. Were nothing known of the movement of glaciers, an instance like this would seem to afford sufficient evidence that such movement exists, and that gravity is the main motive power. From our northern and southern points we could trace the beds of several large glaciers to the west of us, whose upper and lower portions only were visible, the main body of the ice lying hidden by the high intervening spurs.

Ten large glaciers observed by us, and at least half as many more hidden by the mountain from our view, proceeding thus from an isolated peak, form a most remarkable system, and one worthy of a careful and detailed study.

Respectfully yours, S. F. EMMONS,
Assistant Geologist.

CLARENCE KING, Esq., U. S. Geologist:

*Sir*—During the past summer, under your instructions, I visited Mount Hood, in the Cascade range of Oregon, accompanied by Mr. A. D. Wilson, Topographer of the survey, for the purpose of examining the geological and lithological character of the extinct volcano, and also for preparing an accurate topographical map of the mountain and its vicinity, as far north as the Columbia river.

The study of the peak, and its long gently-inclined lava ridges, was replete with important facts, and observations bearing upon the nature and laws that governed the volcanic outflows; but among the most interesting discoveries incident to the trip was the finding of existing glaciers upon the southern slope of the mountain.

The summit of Mount Hood exposes upon the east, north, and northwest sides a bold, precipitous, jagged mass of rock, which forms the outer wall of the old crater, encircling it for three-fifths of the circumference. The remaining portion of the wall is wanting, the other two-fifths presenting a comparatively even slope down to the timber-covered ridges below.

The crater is nearly one-half a mile wide from east to west. The wall upon the inner side rises above the snow and ice filling the basin some 450 feet, while upon the outer side it falls off abruptly for 2,000 feet. This rim of the crater is very narrow; in many places the crest is not more than two feet wide.

Three distinct glaciers have their origin in this basin, each the source of a stream of considerable size; the glaciers of the White, the Sandy, and the Little Sandy rivers.

The White river glacier heads on the eastern side of the crater, and extends in a southeasterly direction. It is nearly a quarter of a mile wide at the head, and about two miles long, extending 500 feet below the line of timber-growth upon the sides of the mountain.

Near the top of the crater a broad transverse crevasse cuts entirely across the glacier. Freshly fallen snow overhangs in projecting banks, the perpendicular walls of ice, making it exceedingly dangerous to approach. At one point only, the fissure may be crossed by an ice bridge. Further down the slope of the glacier transverse crevasses are of frequent occurrence, running nearly parallel with each other; most of them are, however, quite narrow. One broad chasm presented clean, sharply cut vertical sides, for nearly 200 feet in depth, of clear deep blue ice. Marginal crevasses, ice caves and caverns occur; many of the latter are very beautiful and afford fine opportunities for the study of the laminated and veined structure of glacial ice.

Very many of the phenomena attendant upon glaciers elsewhere may be observed here. The terminal and lateral moraines are well marked and extensive. Medial moraines, however, do not appear, because the glacier has no tributaries. Glacial grooving, glacial débris and boulders are quite characteristic.

The glacier of Sandy river is separated from that of the White river, by a high bare ridge, standing boldly up above the ice and dividing the crater into two parts. The glacier descends to the southwest. It is fed by the snow and ice of a somewhat larger area of country, and is considerably broader than the glacier of White river. In length they are about equal.

An immense amount of glacial débris must be annually carried down the stream, whose waters are heavily charged with fine light gray trachytic sand, brought down from above by this moving mass of ice. The character of the rock, a brittle, porous trachyte, is such, that under the wearing action of the glacier it would be easily eroded and ground to fine powder. The very extensive accumulations of sand-banks, which are constantly forming at the mouth of the stream, where it empties into the Columbia river, bear ample evidence of the fact.

The Little Sandy river, a tributary of the main stream, with which it unites, a few miles below the base of the mountain, has its source in the third glacier, which is formed on the western flank of the peak, separated from the Sandy by a high wall, a somewhat broken irregular ridge of trachyte, which extends along the southwest slope of the mountain.

The upper portion or the *névé* of the glacier is inclined at quite a high angle, and is considerably fissured by broad deep crevasses. It has cut into the sides of the mountain a deep, narrow gorge with bare precipitous cliffs. The glacier and the valley of the Little Sandy are both quite narrow.

One of the most marked geological and topographical features of Mount Hood and the vicinity is its very extensive system of extinct glaciers, which everywhere gouged out immense trough-shaped valleys, cutting down deeply into the earlier trachytic lava flows of the old volcano. The entire network of valleys were all connected with two main glaciers; that of Hood river on the north, and the Sandy on the south. The ancient White river glacier was undoubtedly very large; but, as far as my observations have yet extended, had no tributaries.

Respectfully yours,
ARNOLD HAGUE, *Assistant Geologist.*

I propose, if my plans receive the sanction of my chief, General Humphreys, to include Mt. Baker, Mt. St. Helens and Mt. Adams and probably San Francisco Mountain, in this series of monographic surveys; if so, at the close of next summer we shall be in possession of a complete series of maps and studies of all the great isolated volcanic cones of the Western United States.

## ART. XXV.—*Contributions from the Laboratory of the Lawrence Scientific School. No. 13.—On some rocks and other dredgings from the Gulf Stream;* by S. P. SHARPLES, S.B.

SOME time ago Mr. Pourtales gave me for analysis some specimens of bone, rock, and ooze obtained from the bed of the Gulf Stream between Florida and Cuba, while dredging under the direction of the Superintendent of the U. S. Coast Survey.

The bone was a piece of the rib of the Manatee. For comparison with this Mr. Pourtales obtained a piece of the same bone from the skeleton in the Museum of the Boston Natural History Society. He also furnished me with a number of specimens of coral from the adjacent shores.

The phosphoric acid was determined in every case, except that of the fresh bone, by means of ammonic molybdate. In the fresh bone it was determined by Rose's method with mercury. Before treatment with the molybdate the specimen was in every case submitted to the action of the blast lamp for fifteen or twenty minutes in a platinum crucible; by this means every trace of organic matter and carbonic dioxide was expelled.

The first analysis was that of the bone; it was dark colored and almost destitute of organic matter, but still showed distinct traces of fibrous structure. Its density was much greater than fresh bone and it had become very hard. It was from the dredging of May 9, 1868, in 106 fathoms. By the side of it is placed the analysis of the recent bone, which is also calculated as free from organic matter.

| | Old Bone. | Recent Bone. | Recent bone free from organic. |
|---|---|---|---|
| Sp. gr., | 2·83 | 2·07 | |
| $Ca_3P_2O_8$, | 62·40 | 58·16 | 92·79 |
| $Fe_2(P_2O_8)$, | 7·60 | - - - - | - - - - |
| $Ca\,Co_3$, | 26·47 | 4·52 | 7·21 |
| $SiO_2$, | ·34 | - - - | |
| $H_2O$ + organic, | 2·67 | 36·69 | |
| | 99·47 | 99·37 | 100·00 |

The second specimen examined was a hard dark colored rock from the dredging of May 15, 1868, off Sand Key, Florida, in 100 fathoms. It was nearly free from organic matter.

The third specimen was similar to No. 2, except that it contained more organic matter and was intermixed with broken shells and coral, and appeared to be of a more recent formation. It came from the dredging of May 9th, 1868, 11th dredging in 116 fathoms.

No. 4 was a loose rock made up of fragments of corals and seemingly held together by calcic carbonate; it was nearly ite, contained but little organic matter and only a mere trace iron; it was from the third dredging, May 1, 1868, in 188 homs. The mud in external characteristics resembles the lantic ooze, but differed from that examined by Messrs. rbes and Hunter in being almost destitute of silica and ferric ide. The silica consists almost wholly of sponge spicules.

| | . | 3. | 4. | Ooze. |
|---|---|---|---|---|
| Sp. Gr., | 2·81 | 2·79 | 2·61 | |
| $Ca\,CO_3$, | 36·50 | 47·11 | 96·96 | 85·62 |
| $Ca_3P_2O_8$, | 35·54 | 13·15 | 1·20 | .18 |
| $SiO_2$, | ·49 | 1·92 | 2·12 | 1·52 |
| $Fe_2O_3$, | 14·77 | 20·23 | ---- | ·31 |
| $MgCO_3$, | 10·56 | 12·39 | ---- | 4·26 |
| $H_2O$+organic, | 1·46 | 5·89 | ---- | 8·15 |
| | 100·33 | 100·67 | 100·28 | 100·04 |

The corals were examined mainly with reference to the ount of phosphoric acid that they contained. Silliman's alyses, made in 1846, were as good, perhaps, as the state of e science allowed at that time. He seems though to have erlooked one fact in his experiments that Berzelius long ago inted out, that tri-calcic phosphate is soluble to a considerable tent in neutral or alkaline solutions containing organic matr. In order to confirm this fact I took a solution containing out ·01 pr. ct. of glue and added to it some sodic phosphate d then calcic chloride in considerable excess and afterward lcic hydrate to decided alkaline reaction. The filtrate from e precipitate formed was evaporated to dryness and then sted with magnesium wire after Bunsen's method for phoshorus; it gave a strong reaction.

I also took about 100 grams of *Madrepora palmata*, treated it the same way as Silliman did his specimens, with the excepon that it was put into the acid in a single piece, thereby oiding any contamination from the mortar. The precipitate ntained a large amount of organic matter, but on testing it for hosphoric acid, it was found to be almost free from it, while e coral treated in fresh state gave a strong reaction.

| | $CaCo_3$ | $Ca_3P_2O_8$ | $H_2O$ + Organic. |
|---|---|---|---|
| No. 1, *Oculina arbuscula*, N. Car., | 95·37 | ·84 | 3·79 |
| " 2, *Manicina areolata*, Florida, | 96·54 | ·50 | 2·96 |
| " 3, *Millepora alcicornis*, " | 97·46 | ·27 | 2·54 |
| " 4, *Madrepora palmata*, | 97·19 | ·78 | 2·81 |
| " 5, *Agaricia agaricites*, | 97·73 | ·53 | 1·64 |
| " 6, *Siderastræa radians*, | 97·30 | ·28 | 2·42 |
| " 7, *Madrepora cervicornis*, | 98·07 | ·32 | 1·93 |
| " 8, Terebratula shells, | 98·39 | ·61 | 1·00 |

My experiments failed to show more than the sligheest traces of fluorine and I could only find silica in one or two instances and then in mere traces. There were also traces of iron and magnesia.

The above analyses are interesting from several points of view. In the case of the bone we have first a replacement of tri-calcic phosphate by calcic carbonate. The total percentage of lime having diminished, while iron, which was present only in traces in the original bone, exists in considerable quantity.

In regard to the replacement of the phosphate by carbonate one or two explanations may be offered. Calcic phosphate, as shown above, is soluble to a considerable extent in solutions of organic matter. This will account for the removal of part of that salt. Then again during the decomposition of the gelatine of the bone ammonic carbonate would be formed in considerable quantities. The cartilage of bone containing about 18 per cent of nitrogen which would be equivalent to about 123 per cent of ammonic carbonate, alkaline carbonates decompose calcic phosphate more or less completely; they also precipitate calcic sulphate from solution; forming in both cases calcic carbonate. We should therefore have ammonic sulphate and phosphate going into solution while calcic carbonate would be deposited.

We have now remaining only the oxide of iron to be accounted for; the silica being mostly in the insoluble state may be regarded as adventitious. It is a difficult matter in absence of any data concerning the amount of iron in the waters or bottom of the Gulf Stream or Gulf of Mexico to do any thing more than offer a possible explanation of the presence of so large a quantity of this element. Very few of the analyses of sea water give more than a trace of iron. The waters of the open ocean are almost entirely free from it. But those of inclosed seas, such as the Black and Mediterranean, contain a considerable amount. It is also contained in river water, it being absent in but few of the analyses of such water that have been given.

Now we have in the case of the Gulf of Mexico a sea that is for all practical purposes surrounded by land, and we have also large rivers carrying down in all probability great quantities of iron. This coming in contact with decomposing organic matter will be converted at first into carbonate and deposited; it will then be slowly changed into sesquioxide. This is a change that, it is admitted, is slowly going on at the bottom of most ponds.

The analysis No. 2, of rock gives an instance when this change has gone further, and the phosphoric acid has become much reduced in amount, both by the solvent action of the oranic matter and ammonic carbonate and the further deposit of ron, increasing the weight and thus diminishing the percentges of the other components.

Rock No. 3 is evidently composed in part of a rock like No. , derived from bone and in part of fragments of shells and orals; these fragments, being almost destitute of phosphoric cid, aid in reducing the percentage. The iron seems to be the ementing material to a great extent in this case.

No. 4 is more recent and consists almost entirely of decayed hells and corals. The magnesia in Nos. 2 and 3 is evidently lerived from the sea water, it having replaced part of the lime.

These specimens were selected from among a great number s being typical of the different deposits met with in the dredgng. These deposits may have a very near relationship to the one beds of South Carolina In the first place I think they how that tendency of calcic phosphate is not toward conentration, but in every case we find the more recent the bone r other material, the more abundant the phosphoric acid.

Now in the case of the bone beds we have, leaving out the ilica, a substance of almost the same composition as bone with the addition of a considerable amount of iron; or, in other words, a composition nearly approaching that of No. 2, with the exception that there is less carbonate of lime.

The much larger amount of sand is accounted for by the nature of the surrounding coasts; in the case of the Gulf, the shores are mostly of coral, while in South Carolina they are siliceous. We also have the bones of land and fresh water animals mixed in with these deposits in such a good state of preservation that they can be recognized, and occasionally we find the imprint of shells from the beds below which may have been exposed at some points.

There is another characteristic described by C. U. Shepard, Jr.,* which applies equally well to the deposits from the Gulf. He says the surface of the nodules is glazed over and pitted with numerous small holes; this would answer very well for a description of rock No. 2.

Prof. C. U. Shepard's, Sr.† theory of the concentration of calcic phosphate in a mineral by the gradual removal of calcic carbonate by solution in carbonic acid does not seem tenable in view of the fact that calcic phosphate is also soluble in carbonic acid. The large amount of alkaline carbonates that would also be formed during such a process must also decompose to a considerable extent the calcic phosphate.

Cambridge, Dec. 1, 1870.

* This Journal, II, vol. xlvii.

† This Journal, II, vol. xlvii, p. 338.

## Art. XXVI.—*Calorimetric Investigations*; by R. Bunsen.*

### 1. *The Ice Calorimeter.*

The calorimetric methods hitherto in use are attended with the disadvantage that proportionately large quantities of the calorimetric fluid, as well as of the substance under investigation, must be employed, in order that the loss of heat which unavoidably attends the measurements may be so reduced that all corrections therefor may be small in comparison with the amount of heat to be measured. In the determination of specific heat, especially when the more exact of the methods previously in use are employed, satisfactory results can hardly be anticipated when the amount of material used in the experiments is less than from 10 to 40 grams. The preparation of the rarer substances, in a state of absolute purity, in such quantities often presents almost unsurmountable difficulties, and it is perhaps only on this account conceivable that we are not acquainted with the specific heats even of all the elements which have been isolated in a state of purity, although these determinations are of fundamental importance for the establishment of the atomic weights.

The instrument described in the following pages is designed to aid in overcoming this disadvantage. It is based on the principle of measuring the amount of ice melted by the communicated heat by means of the diminution in volume which this ice undergoes on melting.

The instrument, fig. 1, which was made at the glass blower's lamp, consists of an inner glass vessel, *a*, having the form of an ordinary test tube and melted into the cylindrical glass case *b*. From this case *b* issues the glass tube *c*, to whose upper extremity the iron head-piece *d* is cemented. The inner vessel *a* is filled from $\alpha$ to $\mu$, the outer case *b* from $\beta$ to $\lambda$, with previously boiled water; the remainder of the case *b* together with the tube *c*, is filled up to the height $\gamma$ with previously boiled mercury. In order to arrange the apparatus for use, a cylinder of ice enclosing the entire vessel *a* is produced in the case *b*, the whole apparatus is then surrounded with snow in a large vessel, and the calibrated scale tube *s*, which has been cemented into the cork with fine sealing-wax, is screwed down through the mercury of the head-piece *d* very tight into the opening of the tube *c*, whereby the scale tube fills itself with mercury. In order that the pressing in of the stopper may be unattended with danger for the rather fragile apparatus, the instrument is

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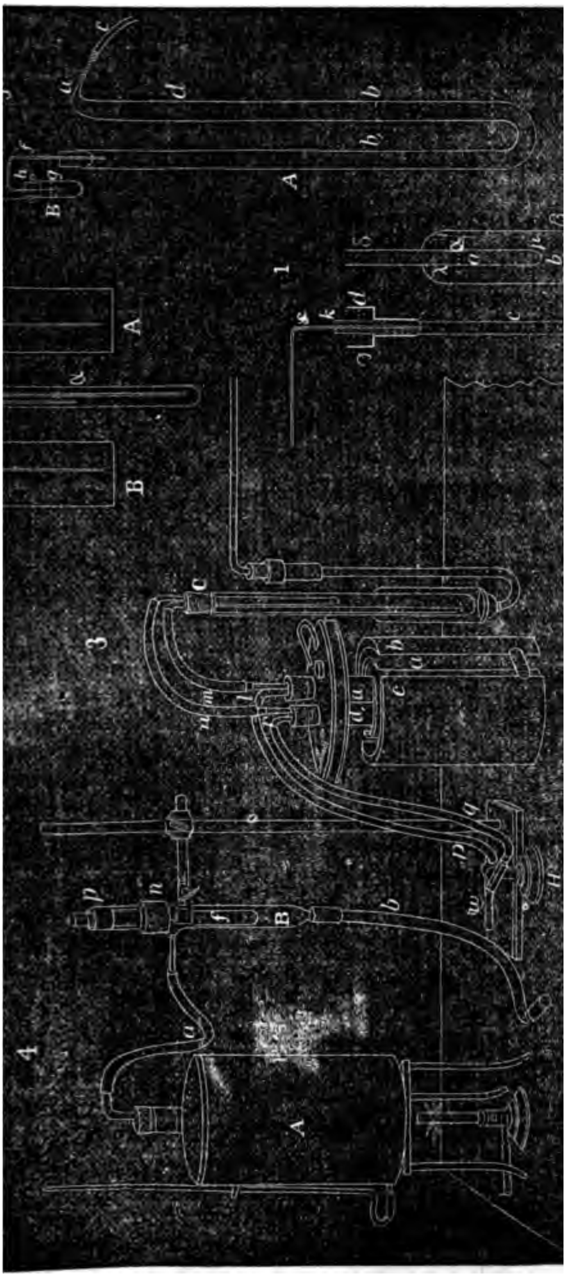
* Translated for this Journal, with permission of the author, from Poggendorff's Annalen der Physik und Chemie, Bd. CXLI, S. 1, by Dr. G. E. Moore, of San Francisco.


1
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fastened on a heavy iron stand by means of a vice, whose jaws surround tightly the lower part of the iron head-piece *d.*

The amount of heat which a body evolves in cooling from a given temperature to 0° C., is determined by dropping it into the water in the vessel *a* and thereupon closing the vessel at $\delta$ with a cork, to prevent any circulation of air. If the problem be the relative measurements of quantities of heat, as in the determination of specific heats, then the standard of comparison is directly afforded by the number of scale-divisions which the mercury thread has passed on its retreat. If the readings are rendered in an absolute measure, as for instance, in grams of melted ice, or in units of heat, as the unit in the following pages, (always that quantity of heat being understood which one gram of water at 0° C. absorbs in order to raise its temperature to 1° C.), then it is only necessary to multiply the readings on the scale with a constant which results from the following consideration.

A mercury thread measured in the scale tube, which has the temperature $t^\circ$ and occupies T divisions of the tube after being corrected by the calibration table, weighs $g$ grams. Let further the specific gravity of mercury at 0° C. be $S_q$, its coefficient of expansion $\alpha$, then is the volume $v$ of a corrected division on the scale, measured in cubic centimeters,

$$v = \frac{g\,(1+\alpha t)}{S_q T}.$$

For the instrument which I used, the values were:

$$g = 0{\cdot}5326 \qquad \alpha = 0{\cdot}0001815 \qquad t = 9^\circ \text{ C.}$$
$$S_q = 13{\cdot}596 \qquad T = 507{\cdot}4$$

and therefore

$$v = 0{\cdot}00007733 \text{ c.c.} \quad - - - - - - - - - \quad (1)$$

If the specific gravity of ice at 0° C. be denoted by $S_e$, the specific gravity of water at the same temperature by $S_w$, the weight of melted ice expressed in grams, which corresponds to the volume $v$, that is, to one scale division with $p$, then is

$$\frac{1}{\frac{1}{S_e} - \frac{1}{S_w}} = \frac{p}{v}$$

or

$$\frac{v\,S_w\,S_e}{S_w - S_e} = p \quad - - - - - - - - \quad (2)$$

With regard to the specific gravity of ice we have many observations. The following comparison shows how little they agree among themselves. For $S_e$

| | | | |
|---|---|---|---|
| Thomson found | 0·920 | Plücker and Geissler, | 0·920 |
| Heinrich, | 0·905 | | |
| Osan, | 0·927 | Kopp, | 0·908 |
| Royer and Dumas, | 0·950 | Dufour, | 0·922 (max.) |
| Brunner, | 0·918 | Dufour, | 0·914 (min.) |

With so slight an agreement between these different observers, it appeared to me indispensable to determine, with greater exactitude than has hitherto been possible, the value of $S_e$ necessary for the calculation of the constant *p*. I employed for this purpose the following method, in which the sources of error which have made the previous determinations uncertain have been entirely avoided: Fig. 5 is a thick walled U-shaped tube, of difficultly fusible glass, which has been drawn out at *a* to a thick walled point. This is filled with mercury to *b b*, and both limbs are well boiled out, as is done with barometers. The point *a* is provided with a small rubber tube through which, by means of alternate warming and cooling of the air in the limb *a b*, distilled water, free from air, is allowed to enter above the mercury by *b*. If this water be boiled for half an hour and the rubber tube *c* be kept under the surface of water, which has likewise been kept in continual ebullition in a beaker glass, the space *a b* will, as soon as the boiling by *b* is discontinued, fill itself completely with perfectly airless water. The rubber tube *c* is now closed under water by means of a small glass stopper and the point by *a* melted off, which may be easily and safely done with the ordinary non-luminous gas flame, without the aid of the blowpipe, when the part of the tube where it begins to narrow out into the point is so strongly heated that it is filled with steam instead of water. If the apparatus has been weighed before filling with water, and after the filling be weighed again together with the dry point, the weight of the water contained in the instrument will be obtained. The open limb is now completely filled with boiled-out mercury and especially, in order to prevent the adhesion of air bubbles to the glass walls, through a long capillary glass tube. If the apparatus be exposed in the open air to a temperature below 0° C., an ice tube, corresponding to the glass tube, will be formed which at last closes in different places, and still contains water surrounded with ice. By the freezing of these last portions of water the ice already formed is exposed to a very high pressure, which may very considerably alter its specific gravity, may in fact even burst the glass tube eighty-atmosphere strong. In order to remove this disadvantage and permit the ice formation to take place, during its entire duration, under the same pressure, it is simply necessary to sink the whole instrument in sawdust and to expose only the upper part by *a* to air of a temperature below 0° C., after you have previously, in order to prevent the effects of abnormal lowering of the freezing point (Ueber-schruelzung), produced an ice mass by *a*, which is allowed to dwindle by melting to a small granule. The freezing then goes on very regularly from *a* downward to *b* and can be very conveniently regulated by letting the limb containing the water project, according to requirement, more and more above the sawdust. The ice cylinder shows on its basis a very regular hemispherical cavity, which progresses unaltered until its edges touch the mercury by *b*, and the last portions of water have been frozen from above downward. After the formation of ice is at an end, the instrument is still exposed some time to a temperature below 0° C. in order to freeze the last traces of water which exist by *b* between the mercury and the glass walls. The ice cylinder thus formed is perfectly free from air bubbles, and equals in clearness and transparency the finest crystal glass. The piece of apparatus designated in the figure with the letter B is now combined, by means of the cork *e* forcibly pressed in, with the open limb of the apparatus A in such a manner that not a trace of air is included between the cork and mercury, whereby the displaced mercury flows through the capillary tube *f* into the glass vessel, which is filled with mercury to *g*. The capillary tube is cemented with the finest sealing-wax into the smooth and perfectly poreless cork. To cement the cork likewise on the wider tube in which it sits, would be wholly superfluous, as a displacement is as little to be feared as an elastic effect afterward, as I have convinced myself by direct experiment. The instrument thus arranged is placed in a room having the greatest possible constancy of temperature, and is surrounded on all sides with a thick envelope of snow which has, at a temperature above 0° C., become completely coherent without at the same time becoming saturated with water. When, after 6 to 12 hours, the entire instrument has attained 0° C., the mercury vessel is removed from the cork *h*, weighed with the mercury it contains, and, after any mercury which may still adhere to the capillary tube, has been carefully removed, returned to its place. The apparatus is then removed from its envelope of snow, the ice it contains is melted by radiation from a non-luminous gas flame brought in its neighborhood, and it is permitted to attain as before in an envelope of snow, the temperature of 0° C. The mercury vessel is now removed and reweighed. The loss in weight, compared with the first weighing, is the weight of the mercury, whose volume calculated for 0° C. expresses the diminution in volume which the ice cylinder at 0° C. has suffered in melting to water at the same temperature.

Let $G_w$ be the weight of the water frozen,
$G_q$ the weight of mercury which entered the instrument during the melting of the ice,
$S_w$ the specific gravity of water at 0° C.,
$S_q$ the specific gravity of mercury at 0° C.,
$S_e$ the specific gravity of ice at 0° C.,

then is
$$\frac{G_q}{S_q} + \frac{G_w}{S^w} = \frac{G_w}{S_e}$$

and therefore:
$$\frac{S_w G_w}{G_w + \frac{S_w}{S_q} G_q} = S_e.$$

On account of the great accuracy which the method just described permits, it appeared to me superfluous to make more than three experiments. In the first of these the water froze between −3° C. and −5° C., in the second between −1° C. and −3° C., in the third between 0° C. and −2° C. The following weights, reduced to vacuo, were obtained:

| | | |
|---|---|---|
| | $G_w$ = 14·1580 | grams. |
| 1st expt. | $G_q$ = 17·4400 | " |
| 2d " | $G_q$ = 17·4624 | " |
| 3d " | $G_q$ = 17·4757 | " |

If we make further

$$S_w = 0{\cdot}99988 \qquad S_q = 13{\cdot}59600,$$

then the resulting specific gravity of ice $S_e$ will be:

| | |
|---|---|
| 1st experiment, | 0·91682 |
| 2d " | 0·91673 |
| 3d " | 0·91667 |
| Mean of three expts., | 0·91674 |

We have therefore for the terms occurring in equation (2),

$$P = \frac{v\,S_e\,S_w}{S_w - S_e}$$

the values:

$$v = 0{\cdot}00007733 \qquad S_e = 0{\cdot}91674 \qquad S_w = 0{\cdot}99988$$

and thence

$$P = 0{\cdot}00085257.$$

The weight of melted ice $e$ which corresponds to T corrected divisions on the scale is therefore:

$$e = 0{\cdot}00085257\ T \ldots\ldots. (3).$$

Let the latent heat of melting, for water, be $l$, then will one scale division correspond to $p\,l$ of the previously defined units of heat. For the amount of heat $w$, expressed in units of heat, which is indicated by T scale divisions, we have therefore,

$$w = p\,l\,T$$

or, if the value 80·025, hereafter to be determined, be substituted for $l$,

$$w = 0{\cdot}068227\ T \ldots\ldots. (4).$$

As the ice cylinder which surrounds the vessel *a* weighs forty to fifty grams, and it is necessary, on the average, to melt by each experiment only about 0·35 grams of ice, which corresponds to rather more than four hundred scale divisions, it is possible to make with the same ice cylinder as many as 100 different calorimetric determinations and to use the apparatus, arranged once for all, for weeks at a time, when care has been taken that the snow which surrounds the instrument be morning and evening renewed by refilling.

The ice cylinder may be easily produced by a contrivance which is rendered intelligible by fig. 2: A is a sheet tin vessel containing alcohol, B an empty one, both of which are cooled to about −20° C. in a freezing mixture of salt and snow. C represents the inner vessel *a* fig. 1, around which the ice cylinder is to be produced. If suction be applied to the tube *a*, the cooled alcohol of the vessel A will be carried through the vessel C into the vessel B; if suction be then applied in the opposite direction by means of the tube *b*, the alcohol will return through the vessel C into the vessel A. By alternate suction at *a* and *b*, the vessel C may be kept to the height *α* as long as desired at a temperature of −10° C. to −15° C., by means of continually renewed cooled alcohol, and the required ice envelope will be produced in the water mass surrounding the vessel C which is denoted in fig. 1 by *b*. I have given this ice-producing apparatus the form, fig. 3. The *two* semi-cylindrical tin vessels *a* and *b*, which communicate with one another and with the tube *a* by means of tubes above and below, correspond to the *single* vessel A fig. 2, the precisely similar tin vessels opposite these, the outer one of which is denoted by *c*, correspond to the vessel B in fig. 2. These two vessels, each consisting of two concentric chambers, together with the tube *α*, possess, as may be seen, a very large cooling surface, and are sunk in one and the same freezing mixture. The arrangement of the system of tubes, fig. 3, by means of which the circulation of the cooled alcohol is effected, is rendered easy of comprehension, from the fact that the corresponding rubber tubes are designated by the same letters as in fig. 2. The alternate suction to and fro of the alcohol is regulated by the alternating cock H, which communicates with the water air-pump by means of the rubber tube *w*. When this cock is in the one position the rubber tube *q* communicates with the suction tube *w*, the tube *p* however with the atmosphere; in the other position the order is reversed, the suction tube *w* communicates with the rubber tube *p*, and *q* with the outer air. By means of this contrivance, the production of the ice cylinder becomes a very simple operation. The cooling apparatus with its attached rubber tubes is placed in the freezing mixture, *p* and *q* are connected with the alternating cock H, *w* with the water air-pump, the rubber stopper with its tubes $m$ and $n$ is sunk by C in the inner vessel of the nstrument, and finally the tubes $m$ and $n$ are placed on the coresponding glass tubes of the cooling apparatus. If now, after he cock of the water air-pump has been opened, the alternaing cock be turned alternately back and forth, the cooled alcohol tream may be allowed to operate as long as you please in prolucing the ice cylinder. The formation of the latter in the apparatus, which stands quite free in the room, may be beautifully observed with the naked eye or through the telescope, and preents not uninteresting peculiarities. The temperature of the perfectly airless water in the outer vessel $b$, fig. 1, sinks gradully, without freezing taking place, until far below 0° C., while he vessel covers itself externally with an ice crust from the precipitated moisture of the atmosphere; even strong agitation s insufficient to put a stop to this abnormal fluidity. When he temperature has finally sunk very low, a sudden formation of ice takes place, which propagates itself in a few seconds from $\lambda$ to $\mu$. The whole vessel is filled down to this limit with nilky turbid leaves and needles of ice, the water mass from $\mu$ o the mercury surface $\beta$ is on the contrary unfrozen. Now begins, under continued cooling, the first formation of the ice cylinder, which is allowed to increase until its walls have attained a thickness of about 6 to $10^{mm}$. That part of the very egularly formed ice crust which lies below $\mu$ appears perfectly amorphous, clear and transparent as the purest crystal glass; he portion above $\mu$ reaching to $\lambda$ appears turbid and of a texure not dissimilar to the confused coarse-fibrous, after the nstrument has stood several days ready for use at 0° C. in the now this coarse-fibrous texture changes entirely. The ice nass between $\lambda$ and $\mu$ consists now of small rounded transpaent grains of spherical habitus; if, after long use, the instrunent be exposed to the temperature of the room, the individual pheres melt off on their surfaces, detach themselves thereby from the adjacent mass, and rise in the fluid; they then appear t times connected with one another like the cells of yeast.

[To be continued.]

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## ART. XXVII.—*On the Porcelain rock of China;* by Baron VON RICHTHOFEN.—From a letter to Prof. J. D. WHITNEY, dated Shanghai, Nov. 17, 1869.

I HAVE recently made a very pleasant trip of six weeks, going up the Yang-tse to Kinkiang, then into Poyang lake. I visited ome places on its eastern affluents, among them the famous King-te-chin, where the Chinese have made nearly all their porcelain for almost three thousand years. I examined the places from which they take the material, crossed over into

An-hwei and Che-Kiang, and descended the Tsien-tang river to Hang-chan, whence I returned to Shanghai. This is probably one of the prettiest countries in China. The hills are overgrown with that prolific vegetation of Azaleas, Rhododendrons, Weigelia and numberless other kinds of low shrubbery which, on account of their beautiful flowers, justify the appellation of the "Flowery Kingdom," at least for this portion of China.

Its geology is rather monotonous, but by no means devoid of interest. Hardly anything is to be seen of the limestones otherwise so prevalent in China. - On the eastern slope, sandstones occupy the field almost exclusively. They are folded up to high mountain ranges. Next to them in bulk are porphyries (both quartzose porphyry and porphyrite). The greater portion of the sandstones was certainly, the rest probably, deposited in and after the period of the eruption of the porphyric rocks. I cannot undertake to make an estimate of their stupendous aggregate thickness. Yet, they are surpassed in this respect by a formation on which they are superposed in the neighborhood of the watershed. It consists of clayslates, with sandstones occasionally imbedded; the whole formation stands on edge and preserves a W.S.W. to E.N.E. strike with remarkable regularity, the strata dipping at angles of 70 to 80 degrees alternately N.N.W and S.S.E. During a journey of about one hundred and thirty miles, going from S.S.W. to N.N.E., or at an angle of about 45 degrees with the strike of the rocks, I traversed no other formation but those same slates, standing on edge. This was on the western slope of the range. I have to record the unexpected fact, that the material from which the procelain of King-te-chin is made is taken from certain strata intercalated between these slates, and occurring at several places, separated from each other laterally, that is, at angles with the strike of the rocks. It is a rock of the hardness of feldspar (inferior kinds are not so hard), and of a green color, which gives it in some measure the appearance of jade, to which the Chinese, too, compare it. This rock is reduced, by stamping, to a white powder, of which the finest portion is ingeniously and repeatedly separated. This is then moulded into small bricks. The Chinese distinguish chiefly two kinds of this material. Either of them is sold in King-te-chin in the shape of bricks, and as either is a white earth, they offer no visible differences. They are made at different places, in the manner described, by pounding hard rock, but the aspect of the rock is nearly alike in both cases. For one of these two kinds of material, the place Kao-ling ("high ridge,") was in ancient times in high repute; and, though it has lost its prestige since centuries, the Chinese still designate by the name "Kao-ling," the kind of earth which was formerly derived from there, but is now prepared in other places. The application of the name, by Berzelius, to porain *earth* was made on the erroneous supposition, that the ite earth which he received from a member of one of the bassies (I think, Lord Amherst) occurred naturally in this te. The second kind of material bears the name Pe-tun-tse white clay"). I have quite a cargo of both, and of the rocks m which either is prepared. Their examination in the lab- tory may be a subject of some interest.

Near Poyang lake, the edges of these King-te-chin schists are rlain by coal-bearing strata, which are almost undisturbed. e locality (Loping) is the first in China which has become of ctical value to foreign enterprise; it supplies the greater tion of the coal used by the American steamers on the ng-tse. I found not a single fossil plant; but certain layers limestone which overlie the coal carry an abundance of sil shells, almost exclusively Brachiopods, in an excellent te of preservation. Though I could collect only on the ste-dumps at the pits, I gathered a large number both of cimens and species. As for beauty, the collection ranks t among all I have made in China. The fauna differs from se which I found formerly associated with the coal-measures the northern provinces; but as I have no paleontologist to sult with, nor even paleontological books, I do not under- e to say what relation in age it bears to those other coal- ds. *Productus* prevails in number. But the former leading sil, *P. semireticulatus*, is here represented only by a few and all, though very distinct, specimens. Its place is occupied other *Producti* with spirous shells, of which there are several cies; some of them of the shape of *P. horridus*, but costate. irifers are very scarce. There is one *Cyrtia*, several *Orthis*, . But the most curious fossil is one which can only be a honotreta. The natural shell has the shape of a night cap, h an opercule on the top, but no area, and is dotted with at appear to be the basal parts of spines; the folds are irreg- r. The dorsal shell is smooth. Both shells are of a horney stance. *Crinoids*, *Orthoceras*, small *Porcellias*, corals and nges make up the list of the prevailing fossils.

I believe that the comparison of the various faunas which I ve collected in different coal-fields will afford much of interest. two of them are alike, yet all bear a certain resemblance in ew leading types. I have not yet found any locality that orded an opportunity for collecting fossils at different geolo- al levels. But every new observation supports my former clusion, that in the vast extent of China the depositions coal-beds continued during an extraordinarily long period, which it shifted repeatedly to different portions of the ntry. I have some reason for believing that this period nmenced even before the Carboniferous epoch, and, though minating in this, continued on beyond its end.

# ART. XXVIII.—*Notes on Granitic Rocks;* by T. STERRY HUNT, LL.D., F.R.S. SECOND PART.

(Read before the American Association for the Advancement of Science at Troy, August 20, 1870.)

(Continued from page 89.)

CONTENTS OF SECTIONS.—§ 16, Granitic veins of Maine; Brunswick; § 17, Topsham, Paris; § 18, Westbrook, Lewiston; crystalline limestones; § 19, Danville, Ketchum; § 20, Denuded granitic masses; § 21, Banded veins; Biddeford, Sherbrooke; § 22, Veins at various New England localities; § 23, Mineral species of these veins; § 24, Veins in erupted granites; § 25, Geodes in granites; § 26, Veins distinguished from dykes; § 27, Volger and Fournet on the origin of veins; § 28, 29, Certain fissures and geodes distinguished from veins opening to the surface; § 30, 31, Temperatures of crystallization of granitic minerals.

§ 16. IT is in the series of micaceous schists with interstratified gneisses (§ 6) which I have elsewhere provisionally designated the Terranovan series,* that I have seen concretionary granitic veins in the greatest abundance and on the grandest scale. This stratified system, which is well seen in the White Mountains, appears to extend southward to Long Island Sound and northeastward beyond the limits of Maine. It is in this state that I have particularly studied the granitic veinstones of this system, whose history may be illustrated by a few examples from notes taken on the spot. In Brunswick the strata near the town are fine-grained, friable, dark colored, micaceous and hornblendic, passing into mica-schist on the one hand, and into well-marked gneiss on the other, and dipping to the S.E. at angles of from 15° to 40°. Very similar beds are found in the adjoining town of Topsham, and in both places they include numerous endogenous granitic veins. The course of these is generally N.W., or at right angles to the strike, though occasionally for short distances with the strike, and intercalated between the beds; the veins vary in breadth from a few inches to sixty feet, and even more. They generally consist in great part of orthoclase and quartz, with some mica and tourmaline, and offer in the associations and grouping of these minerals many peculiarities, which are met with not only in different veins, but in different parts of the same vein. In some cases, colorless vitreous quartz predominates greatly, and encloses crystals of milk-white orthoclase, often modified, and from one to several inches in diameter. At other times pure vitreous quartz forms one or both walls or the center of the vein, or else is arranged in bands parallel with the sides of the vein, and sometimes a foot or more in thickness, alternating with similar

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* This Journal, July, 1870, page 83. The rocks of this White Mountain series are, in the present state of our knowledge, supposed to be newer than the Huronian system noticed in § 5, to which, with Macfarlane and Credner, I refer the crystalline schists with associated serpentines and diorites of the Green Mountains.

nds consisting wholly or in great part of orthoclase, or of an
mixture of this mineral with quartz, having the peculiar
ucture of what is called graphic granite, or else presenting a
ely granitoid mixture of the two minerals, with little or no
ica, and with small crystals of deep red garnet. Prisms of
ack tourmaline are also met with in these veins, and more
rely beryl and even chrysoberyl. In the rock-cutting on the
wiston railroad, just below Topsham bridge over the Andros-
ggin, there is a fine exhibition of these veins, which present al-
rnate coarser and finer grained layers, traversed by long spear-
aped crystals of dark mica passing from one layer to another.

§ 17. A remarkable example of a vein of considerable dimen-
ons is seen in the feldspar-quarry in Topsham, which occurs in
dark fine-grained friable micaceous schist. At the time of
y visit, in 1869, the limits of the vein were not seen, though
rge quantities of white orthoclase and of vitreous quartz had
ready been extracted. These were each nearly pure, and in
ternate bands, the quartz presenting drusy cavities lined with
markable tabular crystals. One band was made up in great
rt of large crystals of mica, and portions of the vein consisted
a granular saccharoidal feldspar. The famous locality of
d, green and blue tourmalines, with beryl, lepidolite, ambly-
nite, cassiterite, etc., at Mount Mica in Paris, is a huge gran-
c vein, which, with many others, is included in a dark col-
ed very micaceous gneiss.

§ 18. In Westbrook numerous small veins of this kind, hold-
g coarsely lamellar orthoclase with black tourmaline and red
rnet, intersect strata of fine-grained whitish granitoid gneiss.
Windham the dark colored staurolite-bearing mica-schist of
is series is traversed by a granitic vein holding crystals of
ryl. In Lewiston a large vein of coarse graphic granite, hold-
g black tourmaline, and showing fine-grained bands, cuts a
eat mass of bluish gneissoid limestone, which forms an escarp-
ent near the railroad, about half a mile below the town.
is limestone, which dips eastward about 15°, is interlamina-
d with thin quartzite beds, which are seen on weathered sur-
ces to be much contorted. The bluish crystalline limestone
mixed with grains of greenish pyroxene, and includes nodu-
r granitic masses of white crystalline orthoclase with quartz,
closing large plates of graphite, crystals of hornblende, and
ore rarely of apatite. These associations of minerals are met
th in the granitic veins of the Laurentian limestones, to be
ticed elsewhere. The limestone of Lewiston, however,
pears to be included in the great mica-schist series of the
gion, where similar beds, though less in extent, are met with
various places, sometimes associated with pyroxene, garnet,
ocrase and sphene. A thin band of impure pyroxenic lime-

stone, like that of Lewiston, occurs with the mica-schists on the Maine Central Railroad, near Danville Junction, and beds of a purer crystalline limestone were formerly quarried in the southeast part of Brunswick, where they are interstratified with thin-bedded dark hornblendic and micaceous gneiss, dipping S.E. at a high angle.

§ 19. At Danville Junction strata of hornblendic and micaceous gneiss, passing into mica-schists, dip N.E. at moderate angles, and include huge veins of endogenous granite. Two of these appear in the hill just south of the railroad station, apparently running with the strike of the beds. They are seen to rest upon the mica-schist, and in one of them a mass of this rock, three feet in width, is enclosed like a tongue in the granite, which has a transverse breadth of about seventy-five feet. Notwithstanding the apparent intercalation of these granitic masses the proof of their foreign origin is evident in a transverse fracture and slight vertical dislocation of the mica-schists around the broken edges of which the granite is seen to wrap. The endogenous character of this granite is well shown by its banded structure; belts of white quartz some inches wide alternate with others of coarsely cleavable orthoclase, while other portions hold black tourmalines and garnets of considerable size.

The evidence of disturbance of the strata in connection with these endogenous granites is seen on a large scale at the falls of the Sunday River in Ketchum. These mica-schists and gneisses, similar to those already noticed, enclose great masses of endogenous granite, which are seen to be transverse to the strata. On one side of such a mass more than sixty feet wide, the schistose strata are twisted from their regular N.E. strike to the N.W., and so enclosed in the granite as to appear as if interstratified with it for short distances. The banded structure of the transverse granite veins is here very marked. Some portions present cleavage-planes of orthoclase six inches in diameter; other parts, which are less coarse, abound in mica. Similar banded granite veins abound in the adjoining towns of Newry and North Bethel, and sometimes present layers of quartz six inches or more in thickness, besides large crystals of mica, and more rarely apatite. These veins are often irregular in shape and bulging at intervals, and they sometimes run partially across the beds, which seem to have been distended and disturbed, a fact which was also observed in the thin-bedded schists in contact with some of the veins in Brunswick, and is apparently due to the expansive force of crystallization, as noticed in § 27.

§ 20. The locality already described at Danville offers an instructive example of a phenomenon often met with in the region now under consideration, where granitic masses, resist-

the actions which have degraded the soft enclosing schists,
nd out in relief on the surface, and seem to constitute the
k of the country. A careful search will however show that
y are simply veins or endogenous masses of very limited
nensions, rising from out of the mica-schists, which are often
icealed by the soil. This is well seen about the lower falls
the Presumpscott near Portland, where the mica-schists with
ne fine-grained gneisses, dipping S.E. at angles of from 30°
40°, enclose large numbers of granitic veins, which, though
netimes but a few inches in breadth, often measure twenty or
en fifty feet, and are usually very coarse-grained, with white
ca, black tourmaline, and more rarely beryl. They are some-
nes transverse to the stratification, but more often parallel,
d, rising above the soil, are very conspicuous.

§ 21. We have already noticed the exotic granites of Bidde-
d, which are intruded among fine-grained bluish or grayish
icious strata. These latter are traversed by numerous veins
endogenous granite, which are very unlike in aspect to the
rusive rock. One of these veins near Saco Pool, has a diam-
r of about an inch and a half, and presents on either wall a
er of yellowish crystalline feldspar about one-fourth of an
h in thickness, which includes long plates of dark brown
ca. These penetrate the central portion of the vein, which is
roadly crystalline bluish orthoclase, enclosing small portions
quartz after the manner of a graphic granite. The yellow-
n and less coarsely crystalline feldspar with its accompanying
ca, had evidently lined the walls of the vein while the cen-
yet remained open, and had moreover entirely filled a small
eral branch. The same conditions are seen in the filling of
ner veins in this vicinity, which are often much larger, and
esent upon their walls bands of an inch or two of the yellow-
n feldspar with mica.

The successive filling of a granitic vein is still more clearly
own in a specimen from Sherbrooke, Nova Scotia, which I
re to the kindness of Prof. H. Y. Hind. The vein, which is
en to be transverse to the adherent fine-grained mica-schist,
s a breadth of nearly four inches, about two-thirds of which is
mmetrical, and is included between two layers, perpendicular
the walls, consisting of a fine-grained mixture of white feld-
ar and quartz, each about one-fourth of an inch thick, and
rked by subordinate zones, more or less quartzose. Within
ese two bands is a coarser aggregate, consisting of two feld-
ars, with some quartz and muscovite, plates of which, and
ystals of pink orthoclase penetrate an irregular layer of
noky quartz varying from one-eighth to one-half an inch in
ameter. This fills the center of the symmetrical portion of
e vein, on one side of which is the mica-schist, while the other

is bounded by a band of more than half an inch of fine-grained granite with yellowish-green mica, presenting larger crystals of feldspar near the outer margin, where it is succeeded by a layer of pure smoky vitreous quartz of about the same thickness, whose outer surface, against the wall, shows irregular bosses or nodular masses, the depressions between which are occupied by a finely granular micaceous aggregate unlike any other part of the vein in texture. This description may be read in connection with the remarks in § 27.

Dana has described and figured a similar granitic vein, banded with quartz, observed by him at Valparaiso in Chili, (Manual of Geology, 1862, p. 713),* and has moreover maintained that such granitic veins, like ordinary metalliferous lodes, are clearly concretionary in their origin, and have been filled by slow and successive deposits from aqueous solutions. His testimony to the view which I have advocated in this paper had been overlooked by me, or it would have been noticed in § 12.

§ 22. The numerous granitic veins so well known to mineralogists in the mica-schists and gneisses of New Hampshire, Massachusetts and Connecticut, including among other familiar localities, Grafton, Acworth, Royalston, Norwich, Goshen, Chesterfield, Middletown and Haddam, seem from descriptions and from their mineral constituents to be similar to those of Maine, already mentioned. With the exception of Royalston however these localities are as yet only known to me from specimens and descriptions. It is noteworthy that at this last the finely-crystallized beryls are directly imbedded in vitreous quartz, and the same is the case with the blue and green tourmalines of Goshen. A remarkable example of a vein of this character occurs in Buckfield, Maine, described to me by Prof. Brush, where large isolated crystals of white orthoclase, nearly colorless muscovite and brown tourmaline occur in a vein of vitreous quartz. At Paris and at Hebron, Maine, tourmalines are found penetrating crystals of quartz. The flattened tourmalines and garnets found in muscovite at several localities in New England, are well known to collectors, and a curious example of enclosure has been observed by Prof. Brush at Hebron, where crystals of muscovite are encased in lepidolite.

§ 23. The following list includes the principal mineral species found in these granitic veins in New England: apatite, amblygonite, triphylline, autunite, yttrocerite, orthoclase, albite, oligoclase, spodumene, iolite, muscovite, biotite, lepidolite, cookeite, chlorite, chlorophyllite, garnet, epidote, tourmaline, beryl, zircon, quartz, chrysoberyl, automolite, cassiterite, rutile, brookite, uraninite, columbite, pyrochlore, scheelite and bismutite. As I am not aware that chlorite has hitherto been mentioned as a constituent of these veins, it may be said that it occurs in one at Albany, Maine. To the above should probably be added the rare species nepheline, cancrinite and sodalite, which have long been known in boulders of a granite-like rock in Maine. According to information given me by Prof. Brush, green elæolite with white orthoclase and black biotite occurs in a granitic vein twenty feet in breadth, lately observed in the northwest part of Litchfield, Maine.

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* From his Exploring Expedition, Report on the Geology, 1849, p. 570.

§ 24. We have seen that these endogenous veins are found alike in the gneisses, mica-schists, limestones and quartzose strata of this region. They are also met with in the eruptive granites, small fissures in which are sometimes filled with coarsely crystalline orthoclase, smoky quartz, various micas and zircon. Examples of this are seen in the granites of Hampstead, New Brunswick and Mt. Uniacke, Nova Scotia. The fine green feldspar of Cape Ann, Mass., and the micas, cryophyllite and lepidomelane with zircon, described by Prof. Cooke, from the same region, occur in veins in the hornblendic granites of that locality. Small veins cutting a somewhat similar rock at Marblehead, contain crystallized green epidote with white quartz and red orthoclase.

§ 25. The veins which we have described are frequently of very limited extent, and seem to occupy short and irregular fissures, while in other cases the mineral aggregates which characterize them occur in nests or geodes. This is seen near Fall Brook in the Nerepis valley in New Brunswick, where the red micaceous granite is in one part very friable, and presents irregular geode-like cavities, sometimes several inches in diameter, which are partially filled by radiating prisms of black tourmaline, accompanied with quartz and albite crystals, and more rarely small octahedrons of purple fluorine. The enclosing granite is composed of deep red orthoclase, with small portions of a white triclinic feldspar, smoky quartz and black mica. The conditions seen at this place recall the description of the famous locality of feldspars, etc., at Fariolo near Baveno in Northern Italy. The rock, described as a granite, resembles, in a specimen before me, some of the intrusive granites of New Brunswick, and contains a pink and a white feldspar, with a little black mica. It includes veins of graphic granite, and also spheroidal masses, which differ in texture from the mass of the rock and present geodes of considerable size, lined with fine large red and white crystals of orthoclase, accompanied by albite, epidote, quartz, fluorine and a greenish mica (or chlorite) all of which, according to Fournet, are so mingled and interlocked as to show that they are of contemporaneous origin. To these are to be added, as occurring in the geodes, prehnite, calcite, hyalite and specular iron. The orthoclase crystals often have adhering to their opposite faces crystalline plates of albite, which are larger than the planes to which they are attached. The crystals of orthoclase moreover frequently present hollowed-out or hopper-shaped faces, which Fournet happily describes as resulting from the forming of the frame-work or skeleton of the crystals, when the material was not sufficient for their completion. A process analogous to this is often seen in crystallization, whether from fusion, solution or vaporous condensation, giving rise in some cases to external depressions and in others to internal cavities in the resulting crystals. Fournet ascribes the formation of the geodes of the granite of Fariolo to a process of shrinking and a subsequent segregation filling the resulting cavities, in which he is forced to recognize the intervention of water, though by no means admitting the aqueous origin of veins, since he holds even those of quartz to have been formed by igneous injection. (*Géologie Lyonnaise*, *278).

§ 26. When we consider the cause which has produced the fissures in the mica-schists and gneisses of New England, which hold the granitic veins already described, it is to be remarked that their comparative abundance, their shortness and their irregularity distinguish them from the fissures which are filled with eruptive rocks. Examples of the latter may be seen near Danville, Maine, where dykes of fine-grained dolerite are posterior to the endogenous granitic veins here occurring in the mica-schist. These dykes may be supposed to be dependent upon movements in the earth's crust opening deep fissures which connected with some softened rock far below. Through such openings were extravasated the exotic rocks, whether granites or dolerites,—more or less homogeneous mixtures, often widely different in composition from the encasing rocks. The endogenous veins, on the contrary, are distinguished not only by their more or less heterogeneous and often banded structure, but by the fact that their principal constituents are the mineral species most common in the adjacent strata.

§ 27. Volger has attributed the formation of the openings containing concretionary veins to the force of crystallization, which is shown to be very great in the congelation of water and the crystallizing of salts in cavities and fissures. Such a process once commenced in an opening in a rock would, he conceived, be sufficient to make still wider the fissure, which might be fed by fresh solutions passing by capillarity through the pores of the rock. If this process were to become concentrated around several points, the intermediate space might be so opened that free crystallization could go on, resulting in the production of geodes in veins thus formed.

Fournet, on the other hand, suggests that contraction in the cooling of erupted granites gave origin to the fissures and ıow filled or partially filled with crystalline minerals at and we may readily suppose that a process of contrac- ndant upon the crystalline aggregation of the materials entary strata, would give rise to rifts or fissures therein. ons thus produced in the solid rocks become more or pletely repaired, if we may so speak, by an effusion of matter from the walls, and thus are generated geodes, : masses and many veins. That the process imagined er may in some cases intervene, and may act subse- to the one just imagined, is highly probable, though lisposed to assign it but a secondary place in the pro- of vein-fissures. It offers however the most plausible tion of the distortion of the thin-bedded strata already in connection with some of the concretionary granitic ' Maine, which seem by a process of growth to have tward the adjacent beds. The vertical transverse veins nany cases at least, unsymmetrical, as if they had grown e side, while the distortion of the beds, sometimes at- ›y irregular concretions in the banded veinstone, appears pposite wall. The notion that the vein-fissures opened ıllization advanced has been defended by Grüner.

It is not here the place to discuss how far the greater per fissures of the earth are dependent upon the con- of sediments, as just explained, or upon the wider novements of the earth's crust, though even of these it said that they are more or less directly the results of a of contraction. It should however be noted that while ssures of this kind are filled with dykes of erupted § 26), others hold concretionary veins, which are to be ished from the class of veins just described, inasmuch penings in which they were deposited evidently com- ed with the surface of the earth. Examples of these in the lead and zinc-bearing veins with calcite and bary- ich traverse vertically the Carboniferous limestone in l, and enclose in their central portions material of lias- abounding in the remains of a marine and a fresh-water which shows these veins to have been deposited in fis- ommunicating with the surface-waters of the liassic

For a description of these veins by Mr. Charles Moore, Report of the British Association, for 1869, and this , II, 1, 365. Similar evidence is afforded by the exist- rounded pebbles imbedded in veins, as observed in a, and also in Cornwall, where numerous pebbles both of l quartz were found at a depth of six hundred feet in a mented by tinstone and sulphuret of copper. (Lyell, 's Elements of Geology, p. 598). Not less instructive in nection are the observations of Mr. J. A. Phillips, on the silicious veinstones now in process of formation in open fissures in Nevada. (L. E. and D. Phil. Mag. (4), xxxvi, 321, 422, and this Jour., II, xlvii, 138). We cannot doubt that the ancient, like these modern veins, have been channels for the discharge of subterranean mineral waters, and it would seem that while the deposition of the incrusting materials on the walls of the fissure is in part due to cooling, and in part perhaps to the infiltration, in some cases, of precipitants from lateral sources, it is chiefly to be ascribed to the reduction of solvent power consequent upon the diminution of pressure as the waters rise nearer to the surface. This conclusion, deducible from the researches of Sorby on the relation of pressure to solubility, I have pointed out in the Geological Magazine for February, 1868, p. 57. See also this Journal, II, l, 27.

§ 29. There is evidently a distinction to be drawn between veins which have been open channels and the segregated masses and geodes formed in cavities which appear to have been everywhere limited by the enclosing rock. In the former case, a free circulation of the mineral solution would prevail, while in the latter there could be no renewal of it except by percolation or diffusion through the rock. A comparison between the contents of geodes and fissure-veins, whether in granitic rocks or in fossiliferous limestones, will however show that these differences do not sensibly affect the mineral constitution of the deposits.

§ 30. The range of conditions under which the same mineral species may be formed is apparently very great. Sorby, from his investigations of the fluid-cavities of crystals, concludes that the quartz which occurs with cassiterite, mica and feldspar in the granitic veins of Cornwall, must have crystallized at temperatures from 200° to 340° Centigrade, and under great pressure, conditions which we can hardly suppose to have presided over the production of the crystallized quartz found in the unaltered tertiaries of the Paris basin, or the auriferous conglomerates of California. In like manner beryl, though a common mineral of the tin-bearing granite veins, like those studied by Sorby, occurs at the famous emerald mine of Muso in New Grenada, in veins in a black bituminous limestone, holding ammonites, and of Neocomian age, its accompaniments being calcite, quartz and carbonate of lanthanum (parisite). Small crystals of emerald are disseminated through this argillaceous somewhat magnesian limestone, which contains moreover a small amount of glucina in a condition soluble in acids. (Lewy, *Ann. de Ch. et Phys.*, liii, 1–26, and Fournet, *Geol. Lyonnaise*, 455).

§ 31. To these we may add the production of various hydrated crystallized silicates, including apophyllite, harmotome and chabazite, during the historic period in the masonry of the old Roman baths at Plombières and Luxeuil, and by the action of waters at temperatures of from 46° to 70° Centigrade; the presence of apophyllite, natrolite and stilbite in the lacustrine tertiary limestones of Auvergne; apophyllite incrusting fossil wood, and chabazite crystals lining shells in a recent deposit in Iceland. The association of such hydrated silicates with orthoclase, as already noticed (§ 13) and as described by Scheerer, where natrolite and orthoclase envelop each other, showing their contemporaneous formation, with many other facts of a similar kind, lead to the conjecture that orthoclase, like beryl and quartz, and perhaps some other constituents of granitic veins, may have crystallized in many cases at temperatures much lower than those determined by Sorby, and that the conditions of their production include a considerable range of temperature, a conclusion which is, however, probably true to some extent, of zeolites also.

It is proposed to continue the subject of granitic veins, and in a third part of this paper to give some facts in the history of the veinstones of Laurentian rocks.

[To be continued.]

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## ART. XXIX.—*On the Geology of the Eastern Uintah Mountains*; by Professor O. C. MARSH, of Yale College.

ONE of the Expeditions in the Rocky Mountain region, made by the Yale College Scientific party during the past season, had for its special object the study of the vertebrate remains of the Tertiary deposits known to exist in the Green River Valley, but never carefully examined. During this investigation, while endeavoring to reach the junction of the Green and White Rivers, in Utah, the party passed along the base of the Eastern Uintah Mountains, as well as over portions of the range; and as nearly all of this region was entirely unexplored, it is desirable to note its more important geological features.

The route pursued by our party on this expedition was from Fort Bridger, in Wyoming, southeast by way of Henry's Fork to the Green River; thence down the eastern side of the river to the great bend near the mouth of the Vermilion. Then crossing to the western side, and passing over the eastern spurs and foothills of the Uintah Mountains, we proceeded southward to the mouth of the White River. After continuing up this stream for about twenty miles, we returned directly to the Green River, then proceeded to Fort Uintah, and from there struck northward over the Uintah range to Henry's Fork, and back to Fort Bridger by our former route. As the country traversed is entirely impassable for wagons, and it was only with considerable difficulty that a way for our pack-animals could be found, our geological observations were necessarily confined mainly to the immediate route pursued, and even then, in the limited time at our command, could not be systematically conducted. The region passed over, however, proved to be one of the most interesting fields for geological research yet discovered in this country, and hence the results obtained, although fragmentary, will add something to the previous knowledge of Rocky Mountain structure.

Fort Bridger, in Wyoming, from which the Yale party started on their expedition in September last, is situated at the northern base of the Uintah Mountains, about 7000 feet above the sea. The surrounding plain is part of a great basin of denudation, washed out of light-colored clays and soft sandstones of Tertiary age, the deposits in one of the great fresh-water lakes, that replaced the Cretaceous sea from which the mass of the Rocky Mountains emerged. Remnants of the strata removed may be seen at various points around; some in the shape of flat, isolated buttes, and others forming benches, resting horizontally against the sides of the mountains. These fragments serve to show the great original thickness of this lake deposit, which cannot, apparently, have been less than 1500 feet, and may have been much greater. A few miles to the southeast, these soft strata have still further escaped denudation, and are weathered out into fantastic, conical forms, resembling those of the "Mauvaises Terres" formation of Nebraska and Dakota. These bluffs are known in this region as the "Grizzly Buttes," and through them lay our route to the Green River.

A careful examination of this "Bad Land" district soon indicated that a fossil, vertebrate fauna of peculiar interest was here entombed; one apparently older and quite distinct from that preserved in the great Miocene lake-basin east of the Rocky Mountains, which we had recently explored. In the latter deposit, the remains of ruminating mammals were especially numerous, while the entire absence of fishes, and of reptiles, with the exception of a single species of tortoise, was a well marked feature. Here, however, reptilian life had evidently been abundant, and was represented by all its principal forms. Crocodilians, tortoises, lizards, serpents, and fishes had swarmed in the waters of this tropical lake; while Tapiroid mammals, with many smaller quadrupeds, had lived near its borders. Their remains had long been weathering out of the "Grizzly Buttes," which offered so inviting a field, that we devoted a fortnight to their exploration, and were rewarded by the discovery of a large number of extinct vertebrates new to science, which will be described by the writer at an early day.

Proceeding eastward along Cottonwood Creek, and over the divide to Henry's Fork, we found the same Tertiary deposits on

r side, still nearly horizontal, and in places beautifully
gated by layers of light green clays, alternating with others
ırious shades of brown. In addition to the numerous ver-
te remains, a few fresh-water mollusca were observed, espe-
r on Henry's Fork, the more common being *Planorbis spec-*
s Meek, abundant in some of the harder layers, and *Helix*
*ira* Meek. Farther down the stream, and about fifteen
ı from its mouth, several seams of lignite were noticed on the
bank. In the intervening shale were some thin layers of
c hornstone, and others containing great numbers of shells,
ipally Unios and Melanias. One of the latter was appar-
identical with the species described by Professor Hall in
ıont's Report (page 308), as *Cerithium tenerum*, which, how-
with its associate fossils, is clearly a fresh-water type.
w feet under the lignite, were layers of shale full of *Cypris*,
here and there cycloidal fish-scales and coprolites.

few miles below, a red sandstone dipping slightly to the
. makes its appearance on the left bank, beneath the light-
ed Tertiary deposits, and farther down, curves upward into
arp ridge, of highly inclined strata, through which the
m has obliquely cut its way. On the southern side, these
form a wall of sandstone, nearly perpendicular, resem-
; strongly the famous "*Teufels Mauer*" in the Hartz. This
, one of the typical foot-hills of the Uintah range, makes
moid curve along the base of the mountains, from which
trata dip away at various angles. The different colored
stones which compose it are evidently of Mesozoic age,
probably Cretaceous, as they have below them, farther
a the stream, calcareous beds containing undoubted Jurassic
ls. These are in turn underlaid by sandstones, which are
ably Triassic, and these again by well marked Carboniferous
a, near the junction of Henry's Fork with the Green River.
t this point the Green River leaves the great Tertiary basin
h it drains for 200 miles or more, and cuts through the
rn Uintah Mountains by a succession of narrow cañons,
walls of older rocks, whose exact age can be determined
by a systematic study. In continuing our course down
east side of the river, we passed over several high ridges,
posed mainly of hard reddish sandstones and quartzites,
e or less metamorphosed, and apparently without fossils.
general inclination of these beds, which are of great thick-
was to the N.E., or away from the Uintah mountain nu-
s, but the dip varied greatly at different points. Ripple-
cs and oblique lamination showed them to be shallow water
sits, and a subsequent examination of apparently a portion
ie same series, on the western side of the river, rendered it
able that a part of them at least are of Silurian age.

On reaching "Brown's Hole," a narrow valley about thirty miles in length, through which the river flows, a series of more recent beds was met with, that are well developed to the southward, where they have played an important part in shaping the present topography of the country. These strata, which are several hundred feet in thickness, lie nearly horizontal, and are mainly composed of conglomerates, and very soft, white, friable sandstones, which at some localities pass into thinly laminated, calcareous shales. At one point on the right bank of the river, a thin seam of lignite was observed in the white sandstone, and about ten miles below, in a high bluff on the opposite side, some of the calcareous layers had all the physical characters of white chalk, although apparently without the same organic structure. As no fossils were detected in these beds, except some obscure remains of plants, their exact age is a matter of some doubt. That they are Tertiary, however, is rendered probable by the fact that, farther down the river, they are seen to rest unconformably on the upturned edges of Cretaceous rocks.

Finding it impossible to proceed with our pack-animals down the river on the east side, we crossed just above the mouth of the Vermilion, and proceeded in a southwesterly course, by a difficult pass, over the eastern extension of the Uintahs. In ascending the mountains from the river we first found a great development of red and purple grits and sandstones, apparently the same as those seen on the eastern side above, but here dipping about 15° to the S.W. Above these strata, and perhaps ten miles to the south, we passed over a series of bright red, thickly bedded sandstones, having the same general inclination, and at least 1000 feet in thickness. In these beds, also, no fossils were detected during the hasty examination we were obliged to make. Resting conformably on this sandstone, was a bed of gray, siliceous limestone, at least 100 feet in thickness, which formed the summits of several of the smaller elevations between the main Uintah range and the Green River, and by its denudation had strewn the region to the southward with its waterworn fragments. This rock, fortunately, contained a few fossils, the most characteristic of which were specimens of *Productus*, *Spirifer cameratus* Morton, *Athyris subtilita* Hall, *Hemipronites crassus* M. and H., a species of *Zaphrentis*, apparently *Z. Stansburyi* Hall, with fragments of *Fenestella* and *Phillipsia*. These remains clearly indicate the Carboniferous age of the limestone, and, indirectly, throw considerable light on the strata beneath it.

Continuing our journey southward, for fifteen miles or more across an elevated plateau, we came suddenly to the overhanging edge of a great basin, which afforded a most striking illustration of the vast amount of erosion to which this region has been subjected since the mountains attained their present elevaι. From the base of the Uintahs, as far south as the eye ld reach, the soft beds of the more recent formations had n washed away to a depth of one or two thousand feet, leav- at the bottom of the great depression the bare, upturned ;es of the variegated Mesozoic strata on which they had ;ed. The flanks of the adjacent mountains were gashed by p cañons leading into the basin, showing the source from ich the denuding agent came. Our course lay through this in, and descending with great difficulty by an obscure Indian l, we passed on, through dry cañons and over steep interven- ridges to Brush Creek, a small stream which now helps to in this region into the Green River. The rim of this great in where we descended was composed of nearly horizontal s of conglomerate, underlaid by light colored clays and sand- ıes, resting unconformably on the edges of an extensive series ·ed and yellow sandstones and shales, which dip to the south ıy from the mountains, but in places have been much curved folded. The upper, horizontal beds, apparently Tertiary osits, were evidently identical with those observed on the ·en River at "Brown's Hole;" and that valley, as well as this er basin, owes its present size, if not its origin, to the readi- s with which these strata are eroded.

Iear Brush Creek, and about six miles from Green River, a n of bituminous coal was discovered in the side of a dry ge, which cuts through a high ridge of sandstones and les. This seam was about a foot in thickness, and indica- ıs of others were seen at various points in the basin. The ta containing the coal where first seen dip about 65° to the th, and form part of a denuded anticlinal. The weathering ;he thickly bedded sandstone above the coal had developed ;e concretionary masses, some of them fifteen feet in diam- ·, which projected from the cliff, or had fallen into the ravine ›w. As the age of the coal deposits of the Rocky Mountain ion has of late been much discussed, a careful examination made of the series of strata containing the present bed, and ır Cretaceous age established beyond a doubt. In a stratum yellow calcareous shale which overlies the coal series con- ıably, a thin layer was found full of *Ostrea congesta* Conrad, ·pical Cretaceous fossil; and just above, a new and very in- sting crinoid, allied apparently to the *Marsupites* of the Eng- Chalk. In the shales directly below the coal bed, cycloidal scales and coprolites were abundant; and lower down, re- ns of Turtles of Cretaceous types, and teeth of a Dinosaurian ile, resembling those of *Megalosaurus*, were also discovered.

ıfter passing out of the deeper portion of this basin on our southward, and proceeding about ten miles beyond a small am, which on the Government maps is called Ashley's Fork, we crossed a second great depression leading into the Green River Valley. This had been washed out, to a depth of 300 feet or more, in a series of nearly horizontal strata, composed of red shales, sandstones, and conglomerates. In some of the beds there were layers of ash-colored clays, and in these a few mammalian and tortoise bones were found, which indicated clearly the Tertiary age of the deposit. The same beds were seen the next day, near one of the branches of the North Uintah River, dipping about 5° to the N.W., and having beneath them a series of chocolate and ash-colored clays, which, rising gradually, attain a great development farther to the S.E., and form the remarkable Tertiary bluffs along the the Green and White Rivers, which it was our special object to investigate.

Crossing the Green River a few miles above the mouth of the Uintah, we passed eastward to the White River, over an elevated plateau, which was washed out along its sides into the true "Mauvaises Terres" form of conical buttes, beautifully variegated with alternating chocolate, green, and ash-colored layers. An examination of these deposits soon showed that they contained many vertebrate fossils, which were weathering out of the cliffs on every side. Farther up the White River, these remains were more numerous, and large collections were obtained, including many species of Tertiary mammals, reptiles, and fishes, some of which were undescribed. Tortoises were especially abundant, and at one locality no less than eleven of them were seen from one point of view. These various remains proved to be almost all identical with those we had found north of the Uintah Mountains, near Fort Bridger, and hence indicated plainly the synchronism of the two deposits. The great difference in elevation, however, and the character of the intervening region, render it more than probable that they belong to distinct lake-basins, connected in the same system of drainage. To distinguish this ancient lake-region from the Green River Tertiary-basin north of the mountains, the former may appropriately be called the Uintah basin. The stream which connected the two, however, did not flow through the present Green River Valley; although the tongue of Tertiary strata extending up into "Brown's Hole" would seem to point to that depression for a probable inlet from the north.

After exploring the region near the White River for twenty miles or more, and finding the variegated Tertiary clays replaced by hard sandstones and grits of a lower horizon, we turned back, and proceeded by a nearly N.W. course across the Green River to Fort Uintah. Here we procured an Indian guide, who led us nearly N.E. over the mountains by an extremely difficult route. On this journey we first passed over an extensive series of shales and sandstones of various shades of red,—a color

h predominates in nearly all the strata of the Uintah Moun-
. These beds are evidently of Mesozoic age, and incline
o 45° to the southward. At one or two points, large masses
ite compact gypsum were noticed in the sandstones. The
t rocks observed were hard gray and purple sandstones and
tzites, extending to the bottom of the deepest cañons, and
rently forming the central mass of the Uintah range, in
of the granitic nucleus, which gives to the eastern Rocky
ntains and the Sierra Nevadas their most marked character.
hile descending the northern slope of the mountains toward
great Tertiary basin of the Green River, which lay in the
nce, 2000 feet below us, we passed over a high ridge, from
ummit of which appeared one of the most striking and
uctive views of geological structure to be seen in any
try. Sweeping in gentle curves around the base of the
ntains, from near where we stood, many miles to the north-
., was a descending series of concentric, wave-like ridges,
ed of the upturned edges of different colored strata, which
ed successively away from the Uintahs; those nearest to
0° or more, those at a distance, seemingly but little,—alto-
er a scene never to be forgotten. Apparently we had be-
us a geological series from the Palæozoic to the Tertiary,
to study it step by step, as we strongly wished, our limited
forbade, and reluctantly we hurried on our journey. Our
an guide led us across a very deep mountain gorge, called
he hunters of this region "Sheep Creek Cañon," through
h a small stream flows eastward into the Green River. The
of this gorge, where we crossed it, about ten miles above
outh, are composed of light colored shales, and yellowish,
le sandstones, highly inclined, and towering into precipitous
, some of them nearly 1000 feet in height.

ascending the northern bank, through a narrow and almost
ssable side ravine, we passed over a bed of light gray
stone, about thirty feet in thickness, which rested conform-
on the sandstones below, and was inclined to the N.W. at
ngle of 25°. This limestone contained an abundance of
ls of characteristic types, that at once established its Juras-
ge. Among the most interesting of these were two species
*rigonia*, one of *Camptonectes*, a *Volsella*, a small *Ostrea*, a
*tella*, resembling *N. Nebrascensis* M. and H., an *Acteonina*,
a *Chemnitzia*,—nearly all undescribed,—with specimens of
*acrinus asteriscus* M. and H. The right humerus of a small
odilian was found in the same stratum. Resting immedi-
on this fossiliferous limestone, was a series of red and gray
s, with intercalated sandstone layers, perhaps in all 150
in thickness. In the red beds, white gypsum was abundant,
e form of fibrous seams, and especially in interstratified

layers, several of which were one or two feet, and one nearly six feet, in thickness,—a deposit of much scientific interest, particularly in view of its bearings on the origin of gypsum. Next above this series came a bed of yellow sandstone, about 35 feet thick; then 100 feet or more of red and gray shales; and over all, near the head of the cañon, at least 40 feet of yellow and gray sandstone. In the upper part of these beds, *Belemnites densus* M. and H., and a small species of *Rhynchonella* were abundant. The whole series is undoubtedly Jurassic, and probably the best development of the formation yet found in this country.

From this point, we proceeded directly to Henry's Fork, and thence westward, up the stream. Re-examining on our way the "Mauvaises Terres" deposits, we found additional evidence of their early Tertiary age, the lowest beds of the series being evidently Eocene, and resting on the Cretaceous, unconformably. Continuing our journey along our previous route, we arrived safely, after an absence of six weeks, at Fort Bridger.

To Major R. S. LaMotte, in command of this Post, and his associate officers, including Lieut. W. N. Wann, who had charge of our escort, our best thanks are returned for valuable assistance, and many kind attentions. Our grateful acknowledgments are likewise due to Hon. W. A. Carter, and Dr. J. V. A. Carter, residents at the Fort, for important information in regard to the surrounding country, and generous hospitalities.

Yale College, January 20th, 1871.

## ART. XXX.—*On the System of the Batrachia Anura of the British Museum Catalogue;* by E. D. COPE.

UNTIL 1858 the Batrachia Anura was a group of animals to which but little attention had been turned, and for which no detailed system based on any general investigations, had been proposed. It was, therefore, a considerable addition to knowledge when the catalogue of the British Museum appeared in that year, and nearly doubled the number of species already known, and arranged them in a system which went into some detail of structure. This detail was, however, almost entirely with reference to external characters. This fact is sufficient to excite question as to the coincidence of the system adopted, with that of nature, and a full examination into the general anatomy of the order, has answered such question unfavorably to it in a very decided manner.* But as authors who have subsequently written do not seem to be at all aware of the demerits of this system, it is proposed here to point out some of them.

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* See the writer on the classification of *Batrachia Anura*, Nat. History Review, 1865, and Jour. Acad. Nat. Sci. Phila., 1866–67.

In the first place the order Anura is divided into three suborders, the Aglossa without tongue, the Opisthoglossa with tongue free behind, and the Proteroglossa, with the tongue free in front. The first group is natural, having been already established by Wagler and Duméril; while the value of the character used to distinguish between the two last is not more than generic at most. Several genera possess the peculiarity of the "Proteroglossa," which in this system are placed among the Opisthoglossa, while the general affinities of the genus Rhinophrynus, the only one of this supposed suborder, are clearly shown by its structure to be those of the family *Bufonidæ* or the toads, on a very slight examination.

The division of Aglossa is supposed by our author to be represented by two series, *Haplosiphona* and *Diplosiphona*, the first including the previously known representatives of the order, the last, the genus *Myobatrachus* Schlegel. Now this last, as I proved by examination of the type specimen at Leyden in 1863, is a dried example of *Chelydobatrachus Gouldii;* an Australian *Bufonid*, with the tongue shrunken away by drying.*

If we now turn to his primary division *Opisthoglossa*, its principal groups are based on one of the most subordinate characters in the order, viz: the *Oxydactyla* and *Platydactyla*, on the presence and absence of the digital dilatations on the ends of the last phalanges; in other words, tree and terrestrial frogs. As all subsequent writers have repudiated these groups, I will pass them with the remark, that the author's reasons for establishing them,—that the characters are so important in the life history of the species—are abundantly sufficient for suspecting their value.

The further subdivision of these groups is based on a variety of characters, some of importance, having been introduced by Müller and Gray, and others newly introduced of very little value. The manner in which they are used is remarkable, and contrary to what would be expected from an examination of the relations of other animals. That is, the characters are treated as of equal importance in all cases, producing a kind of dichotomous system, each group being equal and similar to others, and presenting none of that successional relation which we know so well characterizes nature's groups. The unfavorable impression is strengthened by a further examination into the structure, and the system is found to be little better than if it had been based, dictionary-fashion, on the first letters of their names.

If we mix thoroughly Günther's groups of tree-frogs and not tree-frogs, as the subdividing characters used by him are the same in each, a criticism of the latter will cover both.

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* This error is perhaps not due to the author of the catalogue, as he has seen no specimens.

The presence and absence of maxilliary teeth is an important character, much more so than the conditions of the digital dilatations,—though the esteem in which I formerly held it has been much diminished by the discovery of the genera *Colostethus* Cope and *Eupemphix* Steindachner. Their presence or absence, together with the perfection or imperfection of the ear, as to tympanum, vestibule and eustachian tubes gives our author occasion for dividing each of his series dichotomously into four groups—or three, in the case of the tree-frogs, since the diagnosis of one of them has no answering group in nature. But the presence or absence of the different parts of the auditory apparatus is a character of far less importance than is here assigned to it. The two nearly allied genera *Scaphiopus* and *Pelobates* are separated into two different primary divisions by it, the last to be associated with the *Bombinator* and the first with *Alytes* and *Helioporus*, two genera quite remote in affinities, as well as from the most widely separated regions of the earth. Thus *Helioporus* is Australian, *Alytes* European, and *Scaphiopus* American, and each has sundry allies in its own country, with which it should be arranged. Other most remotely allied genera are associated because of agreement in the structure of the ear. Thus *Discoglossus* is placed in the group *Ranina*, though it represents the family of all others in the *Batrachia anura*, the most remote from the Ranidæ, and which includes beyond a shadow of doubt the genus *Bombinator* which Günther makes not only the type of a different family, but of a distinct primary series, his *Bombinatorina*. Many other instances of the same want of appreciation of natural affinities might be adduced here, but I pass to the toothless or Bufonoid series. Here we find Phryniscid genera separated from their true allies the Engystomidæ, while the latter are placed with much remoter relatives the Bufonidæ, merely because a lesser grade of imperfection of the auditory organs characterizes them.

To come to the characters used to distinguish the families, the same window-pane arrangement prevails. Those employed are the presence or absence of parotoid glands, of palmation of the toes, and of dilated or non-dilated sacral diapophysis. The latter character, noted by Bibron and Gray, is of family value, and the only one of the above to be so estimated. The palmation of the toes is only a generic feature, hardly that in some cases. As this is now agreed to by all good herpetologists, I give it no further notice. The presence or absence of parotoid glands is quiet as worthless in this connection. Thus *Scytopis venulosus* has or has not an immense "parotoid" covering the head and back indifferently, as both Steindachner and myself have observed independently. *Alytes* and *Bombinator*, two European genera of Discoglossidæ little known to our author, but most closely allied, have, the one a small parotoid, the other little separated collections of crypts over the dorsal region, and are hence placed in different families by Günther. *Schismaderma* of South Africa is a true Bufo without parotoids, and Paludicola another member of the true Bufonidæ differs from Bufo in this respect, as Bombinator does from Alytes. *Calamita*, a genus of Hylidæ from the Australian region embraces two species, *C. cyanea* Daud. and *C. dolichopsis* Cope. The first of these has a large glandular mass on the scapular and even cranial regions (and as such the type of a peculiar family of Günther, his Pelodryadidæ) while the second has no glandular enlargements whatever; yet Günther (Zoological Record, 1868) states that they are mere varieties of one species.

To go over all the families in detail, would be unnecessary, as published works have already corrected them. Suffice it to say, that of the fifteen into which the non-tree-frogs are divided, but eight appear by their names to represent natural families, though in character not one of them has a good foundation. Of the nine into which the tree-frogs are divided, but two coincide in extent with modern families, and none in characters. One of the latter embraces but one genus, and is called the *Hylaplesiidæ*, though as Peters has shown by autopsy, the *Hylaplesia* of Boie is a Bufonid, probably a true Bufo. The number of families and subfamilies which might have been constructed on such bases as the above, on genera discovered since the publication of this catalogue, would be considerable, but naturalists have, with one exception* not availed themselves of the privilege.

If we examine the genera of this system the extent of the work of reformation already marked out, becomes more apparent. Thus in his Ranidæ, of thirteen genera, but five belong with Rana, and one of these, Heteroglossa, would be a Polypedatid according to Günther's system. Another, *Stenorhynchus natalensis* Smith, was subsequently redescribed as the type of a new genus and species (*Phrynobatrachus Natalensis*) by the director, although generically undistinguishable from another genus of the same author, *Dicroglossus*. The *Cystignathidæ* contains nothing but members of that family, or rather relations of *Cystignathus*, but is a mere fragment compared with the cohorts that really belong to it. The greater part of all the remaining families of tooth-bearing series belong to it, whether tree-frogs or not. The genus *Plectromantis* Peters, with small digital enlargements on the fingers only, should be placed here, as it is very near to, if at all distinct from the type genus *Cystignathus*. The great extent of this family is paralleled by other Neotropical forms, as the *Formicariidæ*, the *Tyrannidæ*, *Characinidæ*, *Chromididæ*,, etc.

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* Mivart, Proc. Zool. Soc. London, 1869, 280. The writer in one or two instances did the same.

As to the "Discoglossidæ," fragments of four families are represented by its five genera, one of which immediately follows, viz: the *Asterophrydidæ*. In the "Brachycephalidæ" there are placed three genera, Pseudophryne, a true Bufonid, and scarcely distinguishable from the genus Epidalea Cope, which embraces the old *Bufo calamita* of Europe; second, Brachycephalus, which is near Phryniscus and belongs to the Phryniscidæ; and third, *Hemisus*, which is nearer by much to *Engystoma*, but probably forms the type of a distinct suborder?

It is not necessary to examine the genera further, but I turn to the species, where it is proper to express more favorable views. Thus science owes to Dr. Günther a debt of gratitude for the collections, in his British Museum catalogues, of convenient diagnoses of species, with references to many works and authors not accessible to all. His books thus become manuals, and indispensable as the last compilation of an extensive and scattered literature. But it is not only as a compiler that his works are valuable. His usual conscientiousness in attempting the accurate discrimination of species is most praiseworthy, though we cannot help thinking that his estimate of the value of species is sometimes a little interfered with by national and personal predjudices. English, French, and American authors fare the worst at his hands, and we freely admit that in the latter case his criticisms are often deserved, so far as they relate to some of the naturalists of a generation or two ago. These will, however, compare favorably with those who commenced the work in Europe, as Klein, Merrem, Laurenti, Shaw, etc. His countrymen do not, however, escape, and Wagler comes in for the charge of having described, after the much and unjustly criticised work of Spix, "a badly-figured specimen of *Ceratophrys ornata*"* as a new genus, *Hemiphractus*. Now *Hemiphractus* is one of the most remarkable and distinct genera of *Arciferous Anura* of South America, the type of a peculiar family, and Spix's figure represents the type species very well. Prof. Peters first restored the genus.

A serious drawback to the merits of the species work, not only of this, but of Dr. Günther's ichthyological works, is his tendency to ignore species.† This view approaches those expressed by Prof. Schlegel in the field of ornithology. Thus distinct species are continually united, and even good genera are not unfrequently found involved in the undigested mass. This probably results from the very poor opportunities of studying the Reptilia and Fishes enjoyed by the author, except in an alcoholic condition; for the European, of all the faunæ, is the most poorly provided with these forms of life. The North American, one of the best provided in these respects, is almost unknown to Dr. Günther, for it is unfortunate for American students that his works in respect to our fauna are of less value than in any other department. It must, however, be added, that some of the older American authors in this field have been quite as bad in another direction, and in respect to furnishing *well contrasted* specific diagnoses, exceedingly derelict. This has been especially apparent in those who indulge in the execrable practice of publishing preliminary descriptions to "secure priority." This, unless reduced to a system of analytic keys, is nothing but a hindrance to science, and results in warning all students off the ground but the writer, an object which it is safe to presume, he generally has in view.

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* One of the Cystignathidæ.

† I do not allude to his "doubtful-species" which he puts to one side as too briefly described, often very justly.

The system then, presented by the Catalogue of the Batrachia Salientia (Anura), is a phenomenon in the history of our science, and is to my mind one of the least successful of the attempts of *skin-zoology* to interpret nature. That I intended my remark made on a former occasion,[*] that it was a "complete and practically useful system," in a euphemistic, if not a pickwickian sense, would, I should think, be sufficiently obvious to any who should compare my system with it. But it is neither euphemistic nor pickwickian for subsequent authors to follow me in abolishing nearly all its leading features and in newly defining all the groups, and then to declare that they adopt Günther's system with a few modifications introduced by me.

In accordance with Günther's system, he was compelled to conclude that the Anura do not display any of the remarkable geographical relations exhibited by other groups of animals, but are rather varied in relation to latitude. This conclusion I have shown to be most erroneous, and that the Anura of all groups, represent the wonderful faunal relations of geographical areas in the strongest light,—in a way not less distinct than any known order of animals or plants.

As opposed to these valuable results, we have the position, that "zoological classification" should "repose on more external and readily ascertainable characters," and that it is "well to turn to such other (characters) as can easily be observed;[†] all which we suppose will only interfere with the progress of knowledge where sincerely believed and held.

[*] On Primary divisions of Batrachia Salientia, Nat. Hist. Rev., 1865.

[†] Mivart, Proc. Z. S. London, 1869, 281–2. This author makes some curious objections to the definitions of some of the groups for example, that of the Arcifera, the parietal fontanelle, etc. The objection is, that these characters mark immature stages of other groups! a point which I have considered in an essay on the "Origin of Genera" subsequently published. It will suffice to state here, that this relation indicates for a character a certain fixed grade of systematic value. The lowest (specific) and some highest, are those that appear earliest in embryonic life.

## ART. XXXI.—*On Foraminifera from the Gulf and River St. Lawrence;* by G. M. DAWSON.

BY way of introduction to these notes, I may state that the reader will find some account of the curious and interesting animals to which the paper relates, with figures of characteristic examples, in vol. iv, new series, of the Canadian Naturalist, p. 413; and that several species found in the Gulf of St. Lawrence have been catalogued by Principal Dawson, in the same Journal, vol. v, page 188 *et seq.* The following tables give, however, the only approach to a complete view of the species and their distribution hitherto attempted.

Many of the deeper samples were small quantities of mud brought up in sounding, by Capt. Orlebar, R.N., of the Coast Survey, and by him kindly presented to Dr. Dawson.

The specimens from Labrador were obtained from material dredged by the officers of the Geological Survey; those from Prince Edward Island were from a specimen secured by C. Robb, Esq.; and those from the Bank of Newfoundland were obtained from the late Sheriff Dickson, of Kingston.

The somewhat extensive series from Gaspé Bay was obtained during a dredging expedition in the summer of 1869. The mud was sampled when brought up by the dredge, and reserved for examination, the depth being ascertained as carefully as possible. Several very rich and interesting samples are also from the dredgings of Mr. J. F. Whiteaves, F.G.S., in Gaspé and its vicinity. Mr. Whiteaves has also gone over this material with care, and has detected some additional species.

The means were unfortunately not at hand for ascertaining the temperature at the bottom. But, though there is reason to believe that the water at Gaspé Bay is somewhat warmer than the Gulf of St. Lawrence in general, the mud as it came over the boat's side felt icy cold to the hand, showing even here what a great effect the iceberg-laden Arctic current has on the bottom temperature. The number of species tabulated must not in every instance be taken as a criterion of the relative richness of the localities, as much often depends on the amount of material at disposal. This is especially the case when comparing dredgings with soundings.

The general aspect of the Gulf of St. Lawrence Foraminifera is northern, and in many places closely resembles the fauna of the Greenland coast and the Hunde Islands, as given in Parker & Jones' Memoir.* The Gulf, at least so far as its Foraminifera are concerned, evidently belongs to the Arctic province, the limits of which skirt the Banks of Newfoundland and pass from thence southward to Cape Breton.

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* Philosophical Transactions, 1865.

The refrigeration of its waters depends on the Arctic current, which, entering the Straits of Belle Isle, floods the whole bottom of the Gulf with water almost at the temperature of the Arctic seas. To these conditions the series of collections from Gaspé offers somewhat an exception, and is of a slightly more southern character, both as regards the species represented and the development which they attain. This difference depends on purely local causes, which, while slightly changing the character, give opportunities for a very abundant development of Foraminifera, more especially of the arenaceous forms. Gaspé Bay in no part exceeds 50 fathoms in depth; is about 20 miles in extreme length, well land-locked, and disturbed by no other current than that caused by the ebb and flow of the tide. The depth is not so great as to allow of the incursion of the cold and deep layer to any great extent, and the proximity of land and the shelter thus afforded tend still further to modify its temperature.

The bottom, in most of the deeper parts, is composed of fine sand and mud, and this it is which favors the very large development of arenaceous forms.

Past the mouth of Gaspé Bay sweeps the very strong tidal current of the St. Lawrence, and immediately we pass the shelter of Ship Head and come within its influence, the changes in the Foraminifera become strikingly apparent. The bottom consisting for the most part of clean gravel or coarse sand, most of the arenaceous forms disappear at once, and instead of the abundance of Nonioninas and Miliolas previously found, a very large proportion consist of *Planorbulina lobatula*, which can hold its own, attached to seaweeds and polyzoans. *Polystomella Arctica* also becomes somewhat prominent, while the Lagenidæ and Entosolenidæ appear in abundance.

What few sandy forms do occur are depauperated and composed of very coarse particles. The Foraminifera as a whole however are very abundant, and in some samples dredged by Mr. Whiteaves almost equal in quantity those in the deeper Atlantic soundings.

In the estuary of the St. Lawrence itself, *Bulimina pyrula* becomes a somewhat common form. Among forms which in the Gulf of St. Lawrence may be mentioned as specially characteristic of deep water, are *Nodosaria* (*Glandulina*) *lævigata*, *Globigerina bulloides*, very small; *Bulimina*, principally *B. squamosa*, also small; *Uvigerina pygmæa*, *Cassidulina*.

From depths greater than 100 fathoms all the Foraminifera are very small and delicate; and Lagenidæ, Buliminidæ, Globigerina bulloides, together with a few depauperated Nonioninæ, constitute the greater part of the fauna. From these depths also come many Diatoms, mostly *Coscinodiscus*, and Sponge spicules. *Polystomella striatopunctata* is almost everywhere prevalent, though it nowhere attains to any very great size, and below about 30 fathoms, becomes small and generally rare, and continues increasing in rarity till it almost disappears at 300 fathoms. In some localities, at about 30 fathoms, *P. Arctica* is abundant, and greatly surpasses in size the ordinary *Polystomellæ* occurring along with it. The remaining *P. striatopunctatæ* also at this depth often show a remarkable proneness to run into modifications resembling one or other of the numerous species and varieties into which the genus is subdivided, but as the transition series are complete, it is very difficult to place the bulk of the specimens satisfactorily under them. It has been thought better in the table to include as many as are easily seen to be modified *striatopunctatæ* under that name. *Nonionina Labradorica*, though not so universally distributed as the above, is a very characteristic species in the Gulf. It seems to be best developed and in largest numbers, at about 30 fathoms. It thins off both in numbers and size as we go into shallower water, and decreases much in size, though not so perceptibly in numbers as the water deepens to 100 fathoms and below. There is a remarkable absence of Miliolas in the estuarine parts of the Gulf, which strongly contrasts with their abundance in Gaspé Bay, and also on the Atlantic coast of Nova Scotia, and south.

One specimen of a curious sandy form of *Cornuspira foliacea* was obtained at a depth of 18 fathoms at Gaspé.

*Biloculina ringens* scarcely occurs above 30 fathoms.

At Murray Bay, which is only about 60 miles below the point where, at least, the surface of the St. Lawrence becomes permanently fresh, the Foraminifera become very scarce and poor. *Polystomella striatopunctata* is the most common, but it has become very small. *Nonionina Labradorica*, *Lituola Canariensis* and *Trochammina inflata* also occur, but all much reduced in size, and scarce relatively to the amount of material examined. On passing from the Gulf to the east of Newfoundland, or to the south of Cape Breton, a change from the Gulf Fauna is immediately detected. *Polystomella striatopunctata*, there so co[illegible] becomes rare. *Nonionina Labradorica* to a great ex[illegible] to appear, and *Uvigerina pygmæa* and *Cassidulinidæ* [illegible]re frequent.

[illegible]enaceous *Hippocrepina*, (fig. 2,)* and *Lituolæ* (figs. 1 [illegible] are most plentiful at depths less than 20 fathoms. [illegible] *scorpiurus* (fig. 4) goes down to the greatest depths in [illegible] Bay, and is yet abundant at 10 fathoms, while the im[illegible] *abyssorum* (fig. 6) appears only at about

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[illegible] refer to the numbers of the wood-cuts.

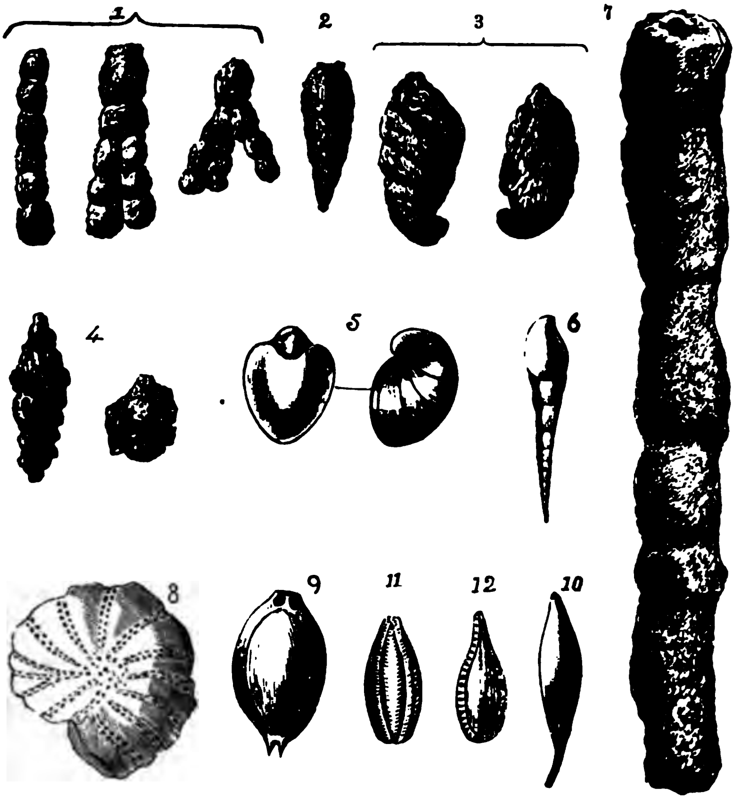


**Fig. 1.** Lituola findens, P. **Fig. 2,** Hippocrepina indivisa, P. **Fig. 3.** Lituola cassis, P. **Fig. 4.** Lituola scorpiurus. **Fig. 5.** Nonionina scapha, var. Labradorica (313 ftms.) **Fig. 6.** Bulimina Presli, var. squamosa (313 ftms.) **Fig. 7.** Rhabdopleura? **Fig. 8.** Polystomella Arctica. **Fig. 9.** Biloculina ringens. **Fig. 10.** Lagena sulcata, var. **Fig. 11.** Entosolenia striato-punctata. **Fig. 12.** Entosolenia marginata. Figs. 1, 2, 3, 4 and 7 are drawn to a scale half that of the other figures.

TABLE I.—*Supplementary List of Peculiar Arenaceous Forms.*

(See figs. 1 to 4 and fig. 7.)

| FORAMINIFERA. | Labrador. | Gaspe Bay, 10 Fathoms, (sand.) | Gaspe Bay 10 to 15 Fathoms. | Gaspe Bay, 16 Fathoms. | Gaspe Bay, 18 to 20 Fathoms. | Gaspe Bay, 16 to 17 Fathoms. | Gaspe Bay, off Grande Greve, 35 Fathoms. | Gaspe Bay, off Grande Greve, 40 to 50 Fathoms. | Gaspe Bay, St. George's Cove. | Riv. St. Lawrence, off Cape Rosier—Whiteaves. |
|---|---|---|---|---|---|---|---|---|---|---|
| Lituola findens, Parker, fig. 1. | ---- | ---- | ---- | *C L | * | * | ---- | ---- | *R | ---- |
| Hippocrepina indivisa, P., fig. 2. | ---- | ---- | ---- | *C L | *C | ---- | ---- | ---- | ---- | ---- |
| Lituola cassis, P., fig. 3. | ---- | * | *C | *C L | ---- | * | ---- | ---- | ---- | ---- |
| Lituola scorpiurus, fig. 4. | * | ---- | *C | *C L | * | *C | *C L | *C | *C | *C L |
| Var., fig. 4. | ---- | ---- | ---- | *C L | ---- | ---- | *C L | ---- | ---- | ---- |
| Rhabdop'eura, fig. 7. | ---- | ---- | ---- | ---- | ---- | * | *C L | * | *C L | *C L |

Table II.—*Showing the Distribution of Twenty-three Gatherings of Foraminifera, from the Gulf and River St. Lawrence, and neighboring parts of the Atlantic.*

(c) common. (r) rare. (s) small specimens. (l) large specimens.

| FORAMINIFERA. | 313 Fathoms, Gulf St. Law., lat. 48° 25′; long. 60° 20′. | 250 Fathoms between St. Pierre and Scatari. | 200 Fathoms, Cape Camille. | 144 Fathoms, Northeast of Anticosti. | 140 Fathoms, Gulf of St. Lawrence. | 40 Fathoms, Cape St. Nicholas. | Labrador. | Banks of Newfoundland. | Off West Cape, Prince Edward Island. | Off South Coast, Cape Breton, 90 Fathoms. | Gaspe, Northwest Arm, 7 Fathoms. | Gaspe Bay, 10 Fathoms, (sand.) | Gaspe Bay, 10 to 15 Faths. | Gaspe Bay, 16 Fathoms. | Gaspe Bay, 16 to 17 Faths. | Gaspe Bay, 18 to 20 Faths. | Gaspe, bet. Ship Head and Cape Bon Ami, 30 Fathoms. | Gaspe Bay, off Grande Greve, 35 Fathoms. | Gaspe, off Ship Head, 30 to 40 Fathoms. | Gaspe Bay, off Grande Greve, 40 to 50 Fathoms. | Gaspe Bay, Grand Greve, St. George's Cove. | Gaspe, River St. Law., off Cape Rosier Village. | River St. Law., Murray Bay, 15 to 20 Fathoms. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nodosaria (Glandulina) lævigata | *R | | | *R | *R | | | | | | | | | | | | * | *S | | * | | *R | |
| Dentalina pauperata | *R | | | | | | | | | | | | | | | | | | | | | | |
| " communis | | | | | | | | | | | | | | | | | *R L | | | * | | *L | |
| Lagena sulcata | | | | | | | | | | | | | | *R | | *R | * | * | *R | *L | *R | | |
| " " var. distoma | * | *R | | * | | | | | | | | *R | | | | | | * | | | | | |
| " " var. semistriata | | | | | | | * | | | | | | | | | | * | * | *R | *L | | *R | |
| " " var. lævis | | *R | | | | | | | | | | | | | | | | | | | | | |
| " " var. substriata | | | | | | | | | | * | | | | | | | | | | | | | |
| Entosolenia globosa | * | | | | | | *R | | | | | | | | *R | | | * | * | | *R | | |
| " costata | | | | | | | *R | | *R | | | *R | | * | | | * | *R S | *R | | * | | |
| " melo, D'Orb. | | | | | | | *R | *R | | | | *L | | | | | *R | | *R | *R | | | |
| " caudata, D'Orb. | | | | | | | | * | | | | | | | | | *S | | *R | | | | |
| " marginata, var. ornata | | | | | | | *R | | | | | | | | | | *S | | | | | | |
| " marginata | | | | | | | | | | | | | | | | | *R S | | | | | | |
| " squamosa | | | | | | | | | | | | | | | | | *R S | | * | | | | |
| " striato-punctata | | | | | | | | | | | | | | | | | *R | | | | | | |
| Polymorphina lactea | *R | | | | | * | | | | | | | | * | *S | | * | | | | | *R | |
| " " var. compressa | | | | | | | * | | *RL | | | *RL | *CL | *L | | | *L | | | | *R S | | |
| Uvigerina pygmæa | | | | | | | | *R | | *CS | | | | | | | *R S | | *R S | | *R | | |
| Globigerina bulloides | *C S | *C S | | * | | | *R | *R | | | | | | | | | S | | *R S | | | | |
| Texularia agglutinans | | | | | | | | *R | | | | | | | *RS | | | | | | | | |
| " " var. biformis | | | | | | | *R | | | | | | | | | | | | | | | | |

| | Sounding. | Sounding. | Sounding. | Sounding. | Sounding. | Sounding. | Dredging. | Dead Balanus brought up on cod hooks. | Sand from an Anchor. | Sounding. | Sounding. | Dredging. | Dredging. | Dredging. | Dredging. | Dredging. | Dredging. | Dredging. | Dredging. | Dredging. | Dredging. | Dredging. | Dredging. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Texularia agglutinans var. Verneuilina polystropha | | | | | | | * | | | | | * | | * | | *R | | | | | | | |
| Bulimina Presli, type | * | | | | | | | | | | | | | | | | | | | | | | |
| " " var. pyrula | | * | *C | *C | * | | | | | | *R | | | | | | | | | *R L | | | |
| " " var squamosa | C | *C | | * | | | *R | | | | | | | | | | | | | | | | |
| " " var. Bolivina costata | | * | | | | | | | | | | | | | | | | | | | | | |
| " " var. marginata | | * | | * | | | | | | | | | | | | | | | | | | | |
| " elegantissima | | | | | | | | | | | | | | | | *C | | | | | | | |
| Cassidulina lævigata | | | | | | | *R | * | | | | | * | | | *R | * | * | * | * | * | * | |
| " crassa | | | | | | | | | | | | | | | | | * | * | * | *R | * | * | |
| Truncatulina lobatula | | | | | | | *CL | *C | | | *S | *R | | | | | *C | | *C | | *L | | |
| Rotalia Becarii | * | *R | | | | | | | | | | | | | | | | | | | | | |
| Pulvinulina repanda, sub var. Karsteni | | *R | | | | | * | | | *CS | | | | | | | * | * | *R | *R | *R S | | |
| Patellina corrugata | | | | | | | | | | | | | | | | | | | *RS | | | | |
| Polystomella crispa var. striato-punctata | *R S | *R | | *RS | * | | * | | *C | | *CS | *S | *C | *CS | * | *S | *C | *R S | *CS | *R S | *S | | *C S |
| Polystomella crispa, var. | | | | | | | | | *R | | | | | | | | | | | | | | |
| " arctica, | | | | | | | | | | | | | | | | | *L | | *L | | *L | | |
| Nonionina scapha, | | | | | | | | *C | | | | | | | | | | * | | | * | | |
| " " var. Labradorica | * | * | * | *C | *C | | * | *R | | | *C | | * | | * | * | *L | *C | * | *C L | *R | * | *S |
| Lituola nautiloidea var. Canariense | | | * | | | | * | | | | *RS | | * | * | *C | | *RS | *C L | | *C | *C L | *C | *S |
| Trochamina inflata | | | | | | | | | | | | *CS | | * | | *CS | | | *RS | | | | *S |
| Cornuspira foliacea? | | *R S | | | | | | | | | | | | *RS | | *L | | | | | *R S | | |
| Quinqueloculina seminulum | *R | | *R | * | | | * | | * | | | *CL | *CL | *CS | | *RS | *R S | *L | | *L | *L | *CL | |
| " var. subrotunda | | | | | | | *R | | | | | | | | | | | | | | | | |
| " var. agglutinans | | | | | | | * | | | | | | *S | * | | *S | | * | *RS | *R | *R S | * | |
| " var. Ferussacii | | | | | | | *R | | | | | | | | | | | *L | | *L | | *L | |
| " bicornis var. elegans | | | | | | | | | *R | | | | | | | | | | | | | | |
| Triloculina tricarinata | | | | | | | | | | | | | | | | *R | *R S | *R S | | | | *R | |
| Biloculina ringens | * | | | | | | *R | | | | | | | | | | | | | *R | *R | *R | |

20 fathoms, and continues from that point increasing in number and size to the depth of 50 fathoms, which is the greatest depth in Gaspé Bay, where alone it has been found.

The distribution of these Foraminifera would tend, with other facts, to show that these organisms, together with most other marine animals of low organization, do not depend, to any great extent, on the depth or intensity of daylight, but almost entirely on the *temperature* of the water, as Dr. Carpenter maintains in his account of his recent deep-sea dredging, so that they would not give very satisfactory evidence of the conditions of deposits of Post-pliocene or other beds, unless other facts were at disposal to show the depth, when the Foraminifera would give valuable assistance with regard to the climatic conditions at that depth. The quality of bottom has, however, much to do with the general *facies* of the Foraminifera, as with other animals. For, as shown above, calm water, with a bottom composed of fine sand and sediment, is particularly favorable to the arenaceous forms, though, even under these conditions, they do not thrive in the very cold, deep water (such as that below 100 fathoms) in the open Gulf. A strong current at once causes all sandy forms to disappear, mostly, no doubt, from want of the fine materials necessary for their shells, and brings in a large preponderance of *Truncatulinas*, *Lagenidæ*, &c.

The arenaceous forms, with the exception of those which are tubular, constitute a series parallel to the calcareous forms, and the members of which graduate into one another. It seems not improbable that the individuals of the same species may assume either appearance. It does not appear, however, that the same individual can present both forms at successive periods. On the other hand, the sandy forms may really constitute a distinct group parallel to the others. Sketches of some interesting forms are given which do not appear to be precisely similar to described species. These have been kindly examined by Dr. Parker, of London, who regards the Lituolæ represented in figs. 1 and 3 as new species, to which he assigns the names *L. findens* and *L. cassis.* The form represented in fig. 2 he regards as the type of a new genus, to which, from the horseshoe-shaped form of the aperture, he gives the name *Hippocrepina*, naming the species *H. indivisa.*

# ART. XXXI.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XII.—*Descriptions of new and imperfectly known Ascidians from New England;* by A. E. VERRILL.

[Continued from page 100.]

## Family, BOTYLLIDÆ (restricted).

The three divisions established by Milne Edwards among the sedentary compound Ascidians differ so much in internal structure as to entitle them to rank as distinct families: BOTRYLLIDÆ, including *Botryllus* and *Botrylloides;* POLYCLINIDÆ, containing *Polyclinum*, *Amouroucium*, *Aplidium*, and the allied forms; DIDEMNIDÆ, including *Didemnum*, *Leptoclinum*, and several other related genera.

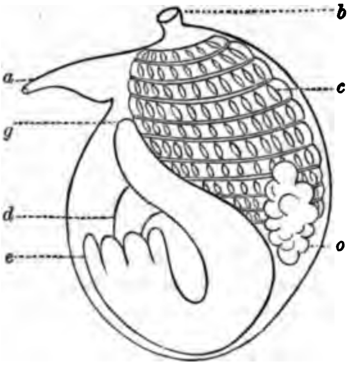
### *Botryllus Gouldii* Verrill. Figures 14 to 19.

*Botryllus stellatus* Gould, Rep. on Inv. of Mass., 1st ed., p. 320, 1841 (*non* Gaetn.).
*Botryllus Schlosseri* Binney, in 2nd ed. Gould Inv. Mass., p. 3, Pl. xxiii, fig. 319, 1870 (*non* Pallas); Dall, Proc. Bost. Soc. Nat. Hist., xiii, p. 255, 1870.

This species commonly forms thick, fleshy, translucent incrustations on sea-weeds and zoöphytes, the form which it assumes depending upon the shape of the object. The masses are often several inches in length and half an inch or more in width. The animals are short oval, as seen at the surface, and

14.

15.



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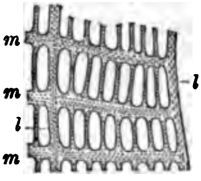

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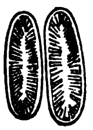


Figure 14.—*Botryllus Gouldii* Verrill, enlarged one half, showing part of a mass attached to the stalk of a *Tubularia*.

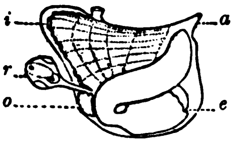
Figure 15.—One of the animals enlarged 20 diameters: *a*, anal orifice; *b*, branchial orifice; *c*, branchial sac; *d*, œsophagus; *e*, stomach; *g*, anus; *o*, right ovary. In this cut the stigmata are too few and too distant and the larger longitudinal vessels were accidentally omitted.

Figure 16.—Portion of the branchial sac of an adult individual, enlarged 40 diameters: *l*, *l*, large longitudinal vessels; *m*, *m*, large transverse vessels, connected by the small longitudinal vessels between the stigmata, and by the large ones.

Figure 17.—Two of the stigmata, enlarged 100 diameters, showing the cilia attached to the inner margin.—(All the figures are from camera-lucida drawings by the author, from Brooklyn specimens).

form circular or elliptical groups, of from five to sixteen or more, surrounding circular or elliptical cloacal openings. The "marginal tubes" are numerous in all parts of the common tissue, the enlarged ends appearing as oval or pyriform spots lighter than the ground color. The branchial openings are small and circular, surrounded by a light halo. The animals differ considerably in form, according to the state of contraction. The anal opening is usually considerably more distant from the branchial than in figure 15, and its tube much larger and more divergent. The outer end or branchial side of the body usually projects considerably beyond the branchial opening, as in figure 18. The form of the stomach also differs, and in preserved specimens it is difficult to determine its normal form. Its surface is finely corrugated or irregularly ribbed, with a glandular structure, which is finely granulated.

18.



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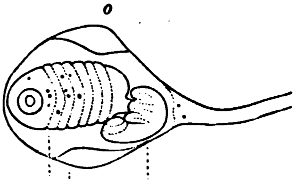


The colors of the specimens were not very carefully examined during life, but the common tissue is greenish-gray and the animals purplish, with a lighter central spot. When preserved in alcohol the tunic is finely speckled with deep purple, the stomach and ovaries are light yellow. The branchial sac has eight or nine transverse purple vessels, and six or more longitudinal ones that are of the same size and color, with smaller, nearly uncolored ones between (figs. 16, 18). The stigmata are narrow elliptical or oblong (fig. 17). Seen externally the branchial orifice is surrounded by a white spot, and another light spot is situated at the anal opening near the inner end. The marginal tubes are dull yellow, with the enlarged ends often opaque white.

Brooklyn, Long I.,—D. C. Eaton; Charlestown, Mass.,—F. G. Sanborn; Salem,—E. S. Morse.

This species appears to be more nearly allied to *B. polycyclus* of Northern Europe than to *B. Schlosseri*, but is apparently quite different from both.

Figure 18.—Another individual, seen from the left side, and enlarged 10 diameters: *a*, anal tube; *e*, stomach; *i*, ventral duct of the branchial sac; *o*, left ovary; *r*, one of the "marginal tubes" developing as a bud.

Figure 19.—The same bud (*r*, fig. 18) enlarged 40 diameters: *c*, branchial sac with seven transverse vessels, faintly developed; the branchial orifice is not formed, but is indicated by a transparent spot surrounded by a faint circle; *e*, stomach and curved intestine; *o*, *o*, ovaries. Some of the purple pigment cells of the tunic are already developed.

[To be continued.]

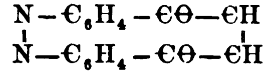
## SCIENTIFIC INTELLIGENCE.

### I. CHEMISTRY AND PHYSICS.

1. *On the synthesis of indigo blue.*—The beautiful discovery of the artificial production of alizarin is now followed by that of indigo blue. The path to this discovery was opened by Baeyer, who by the action of a new reducing agent succeeded in forming the first derivative of indigo free from oxygen—*indol*, and subsequently in preparing this artificially. The same chemist also reduced isatin to indigo blue, giving thereby further encouragement to the hope of artificially forming indigo blue itself. By the dry distillation of equal molecules of calcic acetate and benzoate, Emmerling and Engler obtained acetophenon, the methyl-ketone of benzoic acid, $C_8H_8\Theta$. Nitric acid converts this into two isomeric nitro-derivatives, a crystalline body, $C_8H_7(N\Theta_2)\Theta$, which is not susceptible of transformation into indigo blue, and a reddish yellow syrupy compound with the same empirical formula. As the empirical formula shows, two molecules of this body by losing 2 molecules of water and 2 atoms of oxygen would yield one molecule of indigo blue.

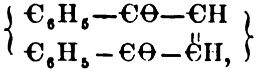
$$2C_8H_7N\Theta_3-2H_2\Theta-2\Theta=C_{16}H_{10}N_2\Theta_2.$$

By using a mixture of zinc-dust and soda-lime at a high temperature, both these changes occurred, the heat serving to remove the water. Afterward it was found that the water might first be expelled by a carefully regulated heat. When small quantities of the mixture are heated over a good Bunsen's lamp, in narrow test tubes, a dark sublimate is formed on the colder parts of the tube, which on heating gives the characteristic violet vapors of indigo blue. The sublimate also gave with lime and ferrous sulphate a solution of indigo-white, which again by oxidation gave the characteristic purple film. The artificial production of indigo-blue, although in extremely small quantity, is thus rendered certain. The authors give for the structural formula of indigo-blue the following scheme:



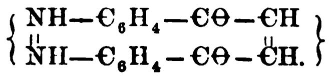
$$\begin{array}{l} N-C_6H_4-C\Theta-CH \\ | \qquad\qquad\qquad\quad\ | \\ N-C_6H_4-C\Theta-CH \end{array}$$

so that it represents the azo-derivative of a peculiar ketone, having the formula:



$$\left\{\begin{array}{l} C_6H_5-C\Theta-CH \\ C_6H_5-C\Theta-\overset{\|}{C}H, \end{array}\right\}$$

but not yet prepared. In view of the facility with which azo-compounds are converted into hydrazo-compounds, indigo-white will have the formula:



$$\left\{\begin{array}{l} NH-C_6H_4-C\Theta-CH \\ \overset{\|}{N}H-C_6H_4-C\Theta-\overset{\|}{C}H. \end{array}\right\}$$

The constitutions of the other bodies belonging to the indigo series will be:

$$\left\{\begin{array}{ll} N & -Є_6H_4-ЄΘ-Є(ΘH) \\ \| & \\ N & -Є_6H_4-ЄΘ-Є(ΘH) \end{array}\right\}\text{Isatin.}$$

$$\left\{\begin{array}{lll} NH & -Є_6H_4-ЄH= & ЄH \\ | & & | \\ NH & -Є_6H_4-ЄH= & ЄH \end{array}\right\}\text{Indol.}$$

$$\left\{\begin{array}{lll} NH & -Є_6H_4-ЄH= & Є(ΘH) \\ | & & | \\ NH & -Є_6H_4-ЄH= & Є(ΘH) \end{array}\right\}\text{Oxindol.}$$

$$\left\{\begin{array}{lll} NH & -Є_6H_4-Є(ΘH)= & Є(ΘH) \\ | & & | \\ NH & -Є_6H_4-Є(ΘH)= & Є(ΘH) \end{array}\right\}\text{Dioxindol.}$$

The method given above for the artificial formation of indigo-blue does not of course hold out any prospects of success in replacing the natural by the artificial product, but is certainly to be regarded as one of the highest triumphs of synthetic chemistry.—*Berichte der Deutschen Chem. Gesellschaft*, $3^{\text{ter}}$ *Jahrgang*, p. 885, (Nov. 28th, 1870). W. G.

2. *On the products of the distillation of coal tar having high boiling points.*—Among the products of the distillation of coal tar having higher boiling points than anthracene, Gräbe and Liebermann found chrysen $Є_{18}H_{12}$. Gräbe has continued the investigation, and has discovered a new hydrocarbon, having the formula $Є_{16}H_{10}$, to which he has given the name of Pyren. This hydrocarbon may be isolated by combining it with picric acid, with which it forms a red crystalline mass, having the formula $Є_{16}H_{10}+Є_6H_2(NΘ_2)_3ΘH$. Ammonia unites with the acid and sets free the pyren in the form of colorless leaves which closely resemble anthracen, are soluble in alcohol, benzol, ether and bisulphide of carbon. It melts at 142° C. and distills at a higher temperature than anthracen. Nitric acid readily converts pyrene into nitro compounds. A mixture of potassic chromate and sulphuric acid converts it into pyrene-chinon. Bromine gives two derivatives, $Є_{16}H_8Br_2.Br_2$ and $Є_{16}H_7Br_3$. Pyrene-chinon is a red powder which is reduced by zinc powder to pyrene, which Gräbe regards as phenylene-napthalin, and for which he gives a complex structural formula.—*Berichte der Deutschen Chem. Gesellschaft*, $3^{\text{ter}}$ *Jahrgang*, p. 742. W. G.

3. *On a new reaction for Chloroform.*—A. W. Hofmann has given a very elegant process by which one part of chloroform in 5000–6000 parts of alcohol may be detected with certainty. The liquid to be tested is poured into a mixture of aniline with an alcoholic solution of caustic soda. When chloroform is present, on gentle heating a violent reaction takes place, with evolution of the characteristic powerful odor of the isonitril. Bromoform and iodoform give the same reaction as well as chloral, but no other known substances.—*Berichte der Deutschen Chem. Gesellschaft*, $3^{\text{ter}}$ *Jahrgang*, p. 769. W. G.

4. *On the homologues of Naphthalin.*—Fittig and Remsen have succeeded in replacing an atom of hydrogen in naphthalin by an atom of methyl or ethyl, by a process similar to that by which ethyl benzol was formed, that is to say, by the action of

dium upon a mixture of mono-bromnaphthalin with iodid of ethyl or ethyl. Methyl-naphthalin is a colorless, limpid, somehat thick liquid, with a faint aromatic odor. It is insoluble in ater, and boils at 231°–232° C. With fuming sulphuric acid it ives methyl-naphthalin-sulphuric acid, $\text{Ȼ}_{10}\text{H}_6\left\{\begin{matrix}\text{ȻH}_3\\ \text{SƟ}_2.\text{ƟH}\end{matrix}\right.$ Ethyl aphthalin is also a colorless, limpid liquid. It boils at 251°–252° ., and forms an ethyl-naphthalin-sulphuric acid, which gives a ell defined copper salt.—*Ann. der Chemie und Pharmacie*, clv, 12. W. G.

3. *On the Spectrum of the Aurora Borealis;* by JOHN BROWNG, Esq., (Monthly Notices of the Royal Astronomical Society, ovember 11, 1870).—During the display of the Aurora Borealis hich occurred on the evenings of the 24th and 25th of October, confined my attention to observing the spectra of the light, takg it in different parts of the sky. When the spectroscope was irected to the more luminous portions, which were generally of a lvery white, the spectrum appeared to me to consist of only one ne. I could not succeed in verifying the position of this line; ut it appeared to be situated between D and E in the spectrum. hen observing the light of the red portions of the sky, a faint d line became visible. I had no means of verifying the position f these lines with any degree of exactitude; but I was able to row into the field of view a faint continuous spectrum from a disnt light, and also the bright yellow sodium-line produced by a irit-lamp.

The color of the green line was very peculiar; had I not been ble to observe it by comparison, I could not have formed any lea of its position. It was an exceedingly light silvery green, or reenish grey, and often seemed to flicker. Besides the two lines articularly described, I occasionally suspected others, one in the d and one in the blue; but I could not be at all sure of this. he color of the light of the aurora seen over the greater portion f the heavens resembled exactly that of the discharge of elecicity from an induction-coil through a vacuum formed from tmospheric air.

## II. GEOLOGY AND NATURAL HISTORY.

1. *Geological Survey of Ohio.*—The publication of the Report the progress of the Geological Survey of Ohio for 1869, is nounced on page 146. It consists of: I, a Report of Progress y J. S. Newberry, Chief Geologist; II, Report of Progress in the econd District, by E. B. Andrews, Assistant Geologist; and I, Report on the Geology of Montgomery Co., by Edward Orn, Assistant Geologist. A colored geological map, about a ot square, accompanies the volume, and shows many rectificaons of former ideas with regard to the rocks. The region of the incinnati uplift, which extends east of north from Cincinnati to e eastern end of Lake Erie, and is occupied about Cincinnati the lowest exposed rocks of the state, the Cincinnati or Hud-

son River beds, is covered to the north, not solely by the Niagara limestone, as has been supposed, but to a large extent by the Lower Helderberg, and mainly the water-lime beds; and passing eastward from this area, the surface rocks are in succession, the Oriskany sandstone, Corniferous limestone, Hamilton group, the Huron Shale or Genesee and Portage, the Waverly group now proved to be Subcarboniferous, and the Coal Measures, the last mentioned covering nearly all of the eastern third of the state. There is also, on the Lake shore, the Erie Shale, several hundred feet thick, corresponding to the Chemung, a rock hitherto confounded with the Huron Shale.

The Huron Shale, as first found by Mr. Hertzer, contains *fossil remains of fishes* and wood inside of large concretions; and one of the fishes, called the *Dinichthys Hertzeri* by Newberry, had a head three feet long by two broad, with the jaws over two feet in length and five inches deep; the two jaws met in front to form one great triangular tooth which interlocked with two in the upper jaw seven inches long and more than three wide.

The discovery of the Subcarboniferous limestone in patches in the state is announced by Prof. Andrews, of the Survey, at page 91 of this volume. The report of Prof. Andrews, which everywhere shows careful research, relates to the eastern or Carboniferous portion of the State, and contains special descriptions of the rocks and iron ore beds, with sections, lists of fossils, observations on economical products, etc.

Among the most interesting results obtained are those of the chemist, Prof. Wormley, who has proved that the sulphur in the coal is not all or mainly in the state of sulphid of iron, but in that of an *organic sulphur compound.*

We cite the following from Prof. Andrews' Report, on page 108: "All the authorities on the subject of coal have hitherto supposed the sulphur to be chemically combined with iron in the form of a bisulphide of iron ($FeS^2$). Prof. Dana, in his recent work on Mineralogy, expresses a doubt in regard to this in the following paragraph, page 756:

'Sulphur is present in nearly all coals. It is supposed to be usually combined with iron, and when the coal affords a *red ash* on burning, there is reason for believing this true. But Percy mentions a coal from New Zealand which gave a peculiarly white ash, although containing from 2 to 3 p. c. of sulphur, a fact showing that it is present not as a sulphide of iron, but as a constituent of an organic compound. The discovery by Church of a resin containing sulphur (see Tasmanite, p. 746), gives reason for inferring that it may exist in this coal in that state, although its presence as a constituent of other organic compounds is quite possible.'

By an examination of Prof. Wormley's table of analyses of the Lost Run coal, it will be seen that in no case is there iron enough in the coal to take up in combination all the sulphur. In No. 27, the sulphur is 1·01 per cent. Adopting for the combination of the bisulphide of iron the proportion given by chemists, viz: iron

7, and sulphur 53·3, in 100 parts, the sulphur in No. 27 would
uire 0·884 per cent of iron, whereas Prof. Wormley finds only
9 per cent. This 0·09 per cent of iron would require only
02 per cent of sulphur to make the usual iron pyrites, and
re are consequently 0·908 per cent of sulphur elsewhere in the
l than in combination with iron.

Another marked illustration of the disproportion of sulphur to
iron in a bituminous coal is found in the analysis of a coal
m Washington county. The coal is a white ash coal, and the
nple analyzed had been in the cabinet of Marietta college for
rteen years, and showed none of the usual tendency to disin-
grate from a change of the bisulphide to the sulphate of iron, a
t which, in crystallizing, breaks the coal by its expansion. The
nple was found by Prof. Wormley to contain only 0·390 per
it of iron, but 3·330 per cent of sulphur. There should have
en but 0·455 per cent of sulphur, if the sulphur were limited to
isulphide of iron."

Prof. Andrews observes, on p. 133, that *gold has been taken*
*m the Drift* at several points in Licking Co., and that in the
nmer of 1868, gold dust was gathered to the value of seventeen
llars.

Prof. Orton was occupied with Southwestern Ohio, which he is
idently studying with much care. Some observations of his in
s region on a peat bed beneath the drift, a discovery of the
rvey, are published on page 54 of vol. 1, of this Journal for
70. A large number of analyses of limestones and other rocks
this part of the state by Dr. Wormley are given on pages 151
153. They show that the Niagara limestone is a true magnesian
nestone, containing 40 to 50 per cent of carbonate of magnesia.

2. *Report on the Geological Survey of Iowa;* by CHARLES A.
HITE, M. D.: Geological Corps, C. A. White, State Geologist;
H. St. John, Assistant; Rush Emery, Chemist. Vol. I, 381 pp.
rge 8vo, with maps, sections and views. Des Moines, 1870.—
e geological survey of Iowa was first undertaken by Professors
mes Hall and J. D. Whitney, who published their valuable
eport, a large octavo volume, in 1858. In 1866 the survey was
sumed, under the order of the State, by Prof. White, but was
fortunately cut short again by the Legislature before the work
s half done, yet not before important results were obtained, as
own in the volume just now issued. It is the first of the two
lumes of which the Report is to consist. This first volume is a
ar and succinct account of the physical geography and geol-
y of the State, with details respecting several of its counties.
ter a general view of the Iowa rocks, it treats in its first part, of
e surface features, including its elevation, drainage system, lakes,
verns, &c.; the Drift and other Quaternary deposits; the soils,
airies and forest-regions; its climate (a chapter, prepared by Mr.
S. Parvin). In its second part, it takes up the geology, speak-
g of the several rocks in order of age, giving their characters,
aracteristic fossils, distribution, etc. Part third, is occupied by

a chapter on the counties of Southwestern Iowa. We select a few facts from the Report.

The thickness of the Lower Silurian is stated as 1160 feet (of which 550 are Primordial); Upper Silurian, (Niagara group) 530 feet; Devonian (Hamilton group) 200 feet; Subcarboniferous, 530 feet; Coal measures, 600 feet; Cretaceous, 330 feet; following which is the Drift; in all, less than 3200 feet for the maximum thickness.

Azoic rocks occur over a few acres in the extreme northwest corner of the State. The Subcarboniferous rocks, which extend northwestward across the State, consist of four subdivisions, the same that are recognized by Worthen in Illinois; 1, the Kinderhook group, the lowest and widest in extent, reaching farthest north; 2, the Burlington limestone, of much less extent northward; 3, the Keokuk limestone (in which the Warsaw limestone is included), with still less of northward extension; and 4, the St. Louis limestone, reaching north nearly as far as the Kinderhook group. The 5th or Upper division, the Chester limestone, does not reach to within a hundred miles of the southern boundary of Iowa. The Coal measures are divided into the Lower, the Middle, and the Upper; and the Upper *is largely limestone*, a rock much like that of the Subcarboniferous, and formerly supposed to be of that group, but proved by Dr. White on both geographical and paleontological evidence to be Upper Carboniferous. The chapter on the Middle Coal Measures is by the Assistant Geologist in the Survey, Mr. O. H. St. John. Sections are given of the Coal measures, as well as of the other rocks.

The subject is throughout presented in excellent style, simple enough for the popular reader, with much of practical value, and yet exact and concise in its scientific descriptions and statements; and the work in its typography as well as its science is an honor to the State. The volume contains a geological map-model of the State, made up of layers of paper colored and lettered to represent the successive rocks—an admirable contrivance of Dr. White's, for popular illustration, and one that may be of great service in public lectures on the science. It is particularly adapted to regions of nearly horizontal rocks.

The second volume of the Report is to be devoted to detailed geology, lithology, mineralogy, and chemistry, and will be accompanied by a geological chart of the State. The Chemical Report will be by Prof. Emery, who, Dr. White observes, "has performed his duties with a zeal and conscientiousness worthy of all admiration."

3. *Report of the Geological Exploration of the Fortieth Parallel, made under the direction of Maj. Gen. A. A. Humphreys, Chief of Engineers, by Clarence King, U. S. Geologist.* Vol. III, *Mining Industry;* by JAMES D. HAGUE, *with Geological contributions by* CLARENCE KING. 647 pp. 4to, with xxxvii plates on stone, and an Atlas. 1870, Washington, Government Printing Office.—The prompt publication of this volume on the Mining

istry of Nevada and Colorado, within a year from the close of
field-work of the 40th parallel survey, is a good omen for the
y completion of the whole report.

he present book, the third volume, although the first in the or-
of publication, opens with a general sketch of the western min-
districts, and an elaborate monograph on the geology of the
shoe district, and the general structure and mode of occurrence
he Comstock lode by Mr. King, covering 97 pages. Then fol-
an exhaustive treatise on the exploitation of the Comstock
s, and the mechanical and metallurgical treatment of their
, by James D. Hague, supplemented by a brief chapter on
Chemistry of the Washoe process by Arnold Hague, the
le occupying 198 pages. This is followed by a chapter of
pages on the mines of Central and Eastern Nevada by J. D.
ue, with geological contributions by S. F. Emmons, and A.
ue, containing descriptions of the Reese River, White Pine
Egan Cañon districts. Chapter VII, by Mr. King, is on the
n River Coal Basin, and contains paleontological contribu-
s by F. B. Meek. The remaining three chapters, by J. D.
ue, are devoted to a general sketch of Colorado and a detailed
unt of gold and silver mining in that territory. The work is
lied with an excellent index, and is accompanied by an atlas
ii plates, admirably engraved and printed by Julius Bien of
York. This volume contains a very large number of newly
rved facts, which have been calmly considered; and the con-
ons therefrom are clearly and candidly set forth. It is not
much to say that the descriptions of the Washoe region, and
illustrative maps showing the geology and topography of the
stock lode by Messrs. King and Gardner, with the maps,
ons and elevations of the different parts of the mines and
kings, surpass in completeness and perfection of execution,
similar work ever published. The chapters by Mr. James D.
ue on the methods of exploitation and treatment of the ores
he different districts give, in a masterly manner, the facts and
ils on these points, and also contain a large amount of care-
collated statistics, never before published, regarding the cost
roduction, and the yield of the mines up to 1870. Mr. Hague's
tical experience in mining, and his thorough knowledge of the
tific principles involved, together with his candid and dis-
inating treatment of the facts under consideration, give great
ht to his conclusions, and render this volume the most valua-
ontribution yet made to the literature of the Mining Industry
he United States. This book should be studied by every one
ested in the development of our western mining regions, and
gress would do a great service to the country if it should
orize a popular edition to be published for general distribution.

r. King announces that his report will be completed in five
mes. Vol. I, Systematic Geology; Vol. II, Descriptive Ge-
y; Vol. III, Mining Industry; Vol. IV, Zoölogy and Paleon-
y; Vol. V, Botany. The whole report forms No. 18 of the
essional papers of the Engineer Department, U. S. Army.

4. *The Literature of Kent's Cavern, near Torquay, Devonshire.*—Besides the five Reports of the Committee for exploring Kent's Cavern, published by the British Association in the volumes for the years 1865 to 1870 inclusive (the first one of which was republished in vol. xliii of this Journal, 1867), various important publications have been made by Mr. Wm. Pengelly, F.R.S., &c., in the Transactions of the Devonshire Association for the Advancement of Science, etc., which have also been reprinted in pamphlet form. These include the following: *The Literature of Kent's Cavern, prior to* 1859, 54 pp. 8vo, 1868.—*Condition of some of the bones found in Kent's Cavern*, 8 pp. 8vo, 1868.—*The Literature of Kent's Cavern, Part II, including the whole of the Rev. J. MacEnery's Manuscript*, 310 pp. 8vo, 1869.—*On the alleged occurrence of* Hippopotamus major *and* Machairodus latidens *in Kent's Cavern*, 25 pp. 8vo, 1869.—Mr. Pengelly was on the British Association Committee, and served as its Reporter. He has also published, in the same Transactions, *On the Antiquity of Man in the South-west of England*, 34 pp. 8vo, 1867.—*On the Introduction of Cavern Accumulations*, 12 pp. 8vo.—*On the Literature of the Caverns near Yealmpton, South Devon*, 25 pp., 1870; and other papers on the Geology of Devonshire.

5. *Atlas der Krystall-formen des Mineralreiches;* von Dr. ALBRECHT SCHRAUF, ersten Custos des K. K. Hof-Mineralien-Kabinets, Wien, etc. 4to, II Lieferung.—Dr. Schrauf of Vienna is one of the best crystallographers of the age, as well as an excellent physicist. He has commenced in this Atlas a large and beautiful work on the crystalline forms of minerals, having just published the second part out of the twenty of which it is to consist. The order in which the mineral species are taken up is alphabetical. The Second part, just now issued, contains plates 11 to 20, illustrating the species from Anglesite to Apatite inclusive, and each plate is occupied with sixteen figures drawn and engraved with great exactness. Under anglesite there are 75 figures; under anhydrite, 16; under apatite, 36; and so on. The text contains crystallographic descriptions of the several figures, and the fundamental dimensions and angles, but without tables of the inclinations between the various planes. Many of the figures are by Dr. Schrauf himself; and in all cases references are given to the authority. The work would be a very valuable companion to any mineralogical cabinet or library. It is printed in a style worthy of the Vienna press.

6. *Synopsis of the Extinct Batrachia and Reptilia of North America;* by EDWARD D. COPE. Part III. pp. 235, to 252 with two large plates.—This third part continues Prof. Cope's very valuable work on our fossil Batrachians, Reptiles and Birds. It is devoted mainly to the birds, and describes at length the species *Sula loxostyla* Cope, from the Miocene of Calvert Co., Maryland, and *Meleagris superbus* Cope, (on a following page, recognized as having been first announced by O. C. Marsh as *Meleagris altus*), from the Post-pliocene of Monmouth Co., N. J. It contains also

ccount of some footprints of Batrachians and Reptiles. Next
ws the Conclusion, containing a synoptical table showing the
tigraphical positions of all the species noticed in his three parts,
another, their distribution in time; and then, general obser-
ons on the relations of the species, and some stratigraphical
rvations.

. *The Phosphate Rocks of South Carolina: their History*
*Development;* by **Francis S. Holmes**, A.M., of Charleston,
. 88 pp. 8vo. Charleston, 1870.—This Report is evidently
nded as a popular exhibition of the resources of South Carolina
hosphatic deposits, and of some of the companies engaged in
ing them. The author advocates the untenable opinion that the
sphatic material was originally an Eocene formation, and that
t occurs now elsewhere was washed out of the Eocene marl
its present position; the multitudes of sharks teeth in the
ene indicating in his view that sharks and other fishes were the
n source of the phosphoric acid.

. *Geognostisch-mineralogische Fragmenta aus Italien.* III
il: *Die Insel Elba;* von Prof. G. **vom Rath**, in Bonn. pp.
-732, from the Zeitschr. d. deutschen geol. Ges., 1870, with
plates.—Like all of Prof. von Rath's papers this is a very
ough treatise, both geologically and mineralogically. The
es contain figures of rare forms of the species Quartz, Ortho-
e, Beryl, Tourmaline, Petalite (Castor), Sphene, and Ilvaite;
des a map of the Island of Elba.

*Lophiotherium sylvaticum.*—Dr. Leidy has so named a spe-
of fossil mammal, based on a portion of the lower jaw found
Prof. Hayden on Henry's Fork of Green river, Wyoming.—
*d. N. Sci. Philad.*, Nov. 15, 1871.

. *Auchenia Californica.*—Several bones obtained by Prof. J.
Whitney, and labeled "under Table mountain near Shaw Flat,
lumne Co., California," have been referred by Dr. Leidy to a
and large extinct species of Lama and named as above.—*Id.*

1. *Protohippus of Leidy.*—Dr. Leidy observes that the genus
*pidion* of Owen, instituted in his paper on the Fossil Equines
Central South America (Phil. Trans. 1869), is essentially that
blished by him in 1858 under the name *Protohippus.*—*Id.*

2. *Fossil Reptiles of the Cretaceous of Kansas.*—Prof. Cope has
gnized among specimens received recently from Kansas, *Elas-*
*aurus platyurus* Cope, *Polycotylus latipinnis* Cope, *Liodon*
*iger* Cope, and three new Liodons, which he names *L. ictericus*,
*Mudgei*, and *L. dyspelor*. The last was allied to *Mosasaurus*
*mbzi*, but was very much larger.—*Id. for Dec.* 6.

3. *General Chart showing the amount and yield of Mineral*
*in Austria in the year* 1868, by **Fr. Foetterle**.—An interest-
Chart published by the Geological Reichsanstalt of Austria,
er the title, Uebersichts-Karte des Vorkommens der Production
Circulation des mineralischen Brennstoffes in der Oesterreich-
en Monarchie im Jahre 1868.

14. *Rhododendreæ Asiæ Orientalis:* a paper by Maximowicz, recently issued (1870) as the 9th fasciculus of the 16th volume of the Memoirs of the Imperial Academy of Sciences of St. Petersburg; illustrated by 4 plates, imp. 4to. In the commencement of this elaborate and very interesting article, Maximowicz explains that the name *Rododendreæ* is preferred to *Rhodoreæ* because the genus *Rhodora* is a mere quasi-abnormal form of a section of *Rhododendron*, taking this genus, as he does, in the most enlarged sense. Also that the characters of scaly and not scaly buds is not completely available, as was thought, for dividing the groups into two tribes as Klotzsch proposed. We have been accustomed to use this character in a subordinate way, when it is very valuable, aware that both modes occur in some genera, such as *Vaccinium*. The main distinction between his *Phyllodoceæ* and his *Eurhododrendreæ* is that of the seed, with a close testa in the former, *scobiform* in the latter. Among the genera of the former he ranks *Rhodothamnus*, founded on *Rhododendron Chamæcistus*. The point which most nearly concerns us is that, notwithstanding the Californian species which we regard as uniting them, Maximowicz keeps up both *Bryanthus* and *Phyllodoce*, the former of Steller's original plant only, the corolla of which he newly describes as "ad basin 4-partita, horizontaliter patens." He also reclaims the genus for Steller, and states that Pallas had done so before him, that Gmelin had copied name and character *verbatim* from Steller, but without mentioning him at all. As to the genera, upon a review of the question under all the light now thrown upon it, we still think that the union proposed is likely to be maintained.

The name *Loiseleuria* is kept up,—although the plant was the original Linnæan *Azalea*,—and with sufficient reasons of history and convenience, which ought here to overbear the rule; for it is impracticable at this day to dissociate the name *Azalea* from the shrubs which every one knows under that name.

Of *Menziesia* Maximowicz recognizes six species; that is, he holds to the distinctness of our eastern *M. globularis* from the north-western *M. ferruginea* (but the characters seem to us insufficient and evanescent), finds a better distinction for the cognate Japanese species in its pentandrous flowers, and has three more apparently well-marked Japanese species.

*Tsusiophyllum*, of a single Japanese species, is an interesting new genus between *Menziesia* and *Rhododendron*, distinguished by its narrow tubular corolla, trimerous pistil, and longitudinally dehiscent anthers.

*Rhododendron*, the great genus of the group, is disposed under eight sections. Four of these are of the terminal-flowered series, all but the last of which make the innovations from separate buds: 1. *Osmothamnus*, DeCandolle's genus, to which *R. Lapponicum*, and the two *Alpenrosen*, with some related species, are added. 2. *Eurhododrendron*, comprising the typical species, under four subdivisions. 3. *Azalea* with annual leaves, answering, with some exceptions, to that genus as admitted by DeCandolle. To a group of this subgenus, otherwise all Chino-Japanese, belongs *R. Rhodora* Don. 4. *Tsusia*, of which the so-called Indian, but really all Chino-Japanese Azaleas of our conservatories are the representatives, in which the innovations come from the same terminal buds with the flowers, and the leaves are less deciduous.

The lateral-flowered series consists of those which bear single or sometimes geminate flowers from lateral scaly buds. 5. *Keysia* Nutt. is formed for a single evergreen Himalayan species. 6. *Rhodorastrum*, with annual leaves and lateral innovations has *R. Dauricum* for its principal representative. 7. *Azaleastrum*, known from the last by its almost rotate corolla, comprises our western *R. albiflorum* Hook., and one or two Chino-Japanese species. 8. The anomalous group *Therorhodion*, with similar corolla, but cleft to the base on the lower side, the innovations extending into a foliaceous bracteate raceme, consists of *R. Kamtschaticum*, which reaches Alaska, and *R. Redowskianum*.

The 8th decade of Diagnoses of new plants of Japan and Mandshuria, by the same author, reprinted from the Academy's *Bulletin*, of the autumn of 1870, is of interest as containing a key to the species of *Elæagnus*, the characters of a new Iris which Miquel had taken for our *I. cristata*, a *Triosteum* which hardly differs from *T. perfoliatum*, and a Mandshurian and a Japanese species of *Nabalus*. A. G.

15. *Flora Australiensis.*—The fifth volume of this great Colonian Flora, by Mr. Bentham, assisted by F. Müller, issued toward the close of 1870, has just been received. It comprises the last orders of *Monopetalæ*, from *Myoporineæ* to *Plantagineæ*, the *Labiatæ* being the largest family, and the *Apetalæ* from *Phytolaccaceæ* to *Proteaceæ;* the latter being of course by far the most important family, and occupying almost half of the present volume of 584 pages. In connection with this we may note the reception of the 6th volume of Ferdinand de Müller's *Fragmenta Phytographiæ* Australiæ (Melbourne, 1867–1868,) containing characters of new species and genera, revisions of various groups, etc., illustrated by lithographic plates of some of the more interesting plants; the present volume mainly devoted to *Monopetalæ* and to *Proteaceæ*, and issued in advance of the corresponding portion of the *Flora Australiensis.* Thanks to two such indefatigable laborers, Australia may soon boast of a noble and unrivalled completed Flora.

A. G.

16. *Marsiliæ and Pilulariæ, revised by A. Braun.*—The *Monatsbericht* of the Berlin Academy of Sciences for August last, from p. 653 to p. 754, is occupied by Prof. Braun with a detailed account of these genera, upon which he has previously published the results of prolonged investigations. His present account is summed up in a tabular view or key to the species of both genera (in German) followed by a systematic arrangement and revision, with full synonymy, habitat, etc. The species of *Marsiliæ* now amount to 53, of which 9 are North American; and of *Pilulariæ* to 5, of which there is one, very little known, in the United States, certainly in Arkansas, probably in Georgia. A. G.

## III. ASTRONOMY.

1. *Solar Eclipse of Dec.* 22.—We copy the following article on the eclipse from *Nature*, the excellent scientific weekly under the editorial direction of the astronomer, Mr. Lockyer, and published by MacMillan & Co. London, and 63 Bleecker St., New York.

*Mediterranean Eclipse*, 1870; by J. NORMAN LOCKYER.—Cloud in Sicily, cloud in Spain, cloud in Africa. Such at first sight might seem to be the only result of all the observations made on the eclipsed sun of 1870.

But, after all, has the oracle been silent? I think not. Dare we, however, say that the great problem of the Corona, that one among the many still outstanding difficulties which the eclipse was invoked to settle, is settled? This, perhaps, would be saying too much, but still, I think, a step in advance has been made. The oracle has spoken darkly, perhaps, but it *has* spoken.

Let me endeavor to put the question as it stood a few weeks ago as briefly as possible.

Beginning the story some few years back we find the corona, a halo of white light around the moon, with a height sometimes represented as equal to the moon's diameter, sometimes more, sometimes less, with a border *à discrètion*,—so much did the drawings vary—regarded as the solar atmosphere.

Some thought the red prominences to be mountains, other observers called them clouds.

The polariscope was brought up with a view of determining whether the corona shone by reflected light or not. The result of this new method of observation was doubtful.

In the Indian eclipse of 1868 M. Janssen, by means of the spectroscope, still another aid, determined that the prominences were masses of hydrogen gas, but there was no final word about the corona. Major Tennant observed that its spectrum was continuous. Later in the same year Dr. Frankland and myself approximately determined the pressure of the prominence gases by means of a new method and laboratory experiments, and at once stated our conviction that the extensive corona, which had been depicted and represented by Kirchhoff and others to be the solar atmosphere, must be something else. This was our idea. I cannot quote our words, for I am writing in Venice and have no copies of our paper with me.

In the American eclipse of 1869 the problem was advanced considerably, perhaps even more considerably than we can yet form an idea of, writing as we must still do doubtfully. I do not refer to the drawings, for they varied considerably, but to the observation that the light of the outer corona, like that of the prominences, gave a bright-line spectrum. But as at least some of the observers gave positions doubtfully, "near C" and "near E," I thought that the explanation was still possible which regarded the corona as of terrestrial origin; that is, which assumed it to be an appearance due to the presence of light in our own atmosphere. The problem was one of such difficulty that there seemed a possibility that, by some unexplained cause, some of the solar light might be diffused and beat out of its course, and then mixing up with the light of the chromosphere, give us a sort of continuous spectrum, with the hydrogen bright lines superposed upon it; in other words, that as the eye perceives a bright, irregular region or glare around the uneclipsed sun, an effect due to our atmosphere, so also the eye might perceive a bright, irregular region or glare around the ***uneclipsed chromosphere during eclipses***, due also to our atmosphere.

One word here about the Chromosphere, the name I have given to the bright-line-giving region outside the photosphere. It has long been clear that the spectroscopic method of observing it when the sun is not eclipsed is not totally effective; that is to say, that we only see a percentage of it—perhaps only a relatively small percentage—but the glowing prominences, that is, those in which there is no evidence of the rapid motion of ejection from the sun, the ejection taking place at all angles from the line of sight, afford evidence that there is probably a layer of cooler hydrogen susceptible of being rendered visible above the ordinary level. Now as these prominences may be 5′ high, it is not unreasonable to suppose that the chromosphere may even extend to that distance, or even a little beyond it.

Hence it was that in the Instructions to Observers, drawn up by Prof. Stokes, and myself, and approved by the organizing committee for this 1870 eclipse, it is stated that—

"THE PRINCIPAL OBJECT to be obtained is to determine whether it is possible to differentiate the outer layers of irregular outline and the streamers (of the corona) from a stratum, say some 5′ or 6′ high round the sun, which may possibly be the limit of the gaseous envelopes above the photosphere."

The spectroscopic observers, therefore, were enjoined—

*a.* "To determine the actual height of the chromosphere as seen with an eclipsed sun; that is, when the atmospheric illumination, the effect of which is doubtless only partially got rid of by the Janssen-Lockyer method, is removed. If the method were totally effective, the C line, the line of high temperature, should hardly increase in height: but there can be little doubt that the method is not totally effective, so the increase in height should be carefully noted."

*b.* "To determine if there exists cooler hydrogen above and around the vividly incandescent layers and prominences."

And the polarisers—

"To examine a detached and selected part of the corona about 6′ from the limb of the sun, and say about 8′ in diameter."

Having got so far, it may be here stated that of the three means of attack, namely, the spectroscope, the polariscope and telescope, and naked eye observations, the spectroscopic method, under certain circumstances, might have been by far the most doubtful, the polariscope method coming next.

With regard to the spectroscopic observations, if we assume that no light whatever is received by and from our own atmosphere, the observations would be easily translated. A pure continuous spectrum would reveal to us solid or liquid matter in the circumsolar regions; a spectrum continuous or not containing bright lines would give us gases or vapors; the ordinary solar spectrum, with its dark lines, would indicate matter incapable of radiation itself, and therefore cool, reflecting to us ordinary sunlight. It is clear that the problem would be complicated if circumsolar matter both reflected sun light and sent us its own; and still more so if we allow that the coronal light may be partly contributed from reflections and refractions in our own atmosphere. Then we have to consider whether the light thus contributed may possibly be due to the photosphere or to the prominences, and we are landed in a maze of difficulties which need not be discussed here.

The system of sketching introduced for this eclipse is at once so simple and final that the only wonder is that it has not been introduced before. The corona must be either solar, atmospheric, or subjective, that is, more or less built up in the observer's eye, this more or less depending *cœteris paribus* upon the brilliancy of the undoubted solar portion. If at all stations, the stations being as wide apart as they have been this time, the drawings are similar, then the corona would be undoubtedly cosmical; if dissimilar, then it would either be terrestrial or subjective; and this point could and would have been settled this time, if the weather had permitted, by arranging the observers *in pairs*, that is, dealing with two observers in each place instead of a single one, and so obtaining the eye-variations.

This being premised, what is the result of the very few observations, comparatively speaking, which have been made? Before I attempt to give any idea of my answer to this question, it is only fair to myself to state that my only sources of information, up to the present time, have been conversations with some of the American members of the Sicilian expedition, a brief telegram from the members of the English party at Agosta, the Rev. S. J. Perry's communication to the *Daily News* of the 2nd instant, and an inspection of some drawings made by the officers of H. M. ships off Aci Reale. At Catania we saw a portion of the corona for 1½ seconds through a cloud, and that was all: and the day after the eclipse, before the more fortunate members of my party returned, it became my duty to proceed to Malta in H. M. S. *Lord Warden* to attend the court-martial on the officers and crew of the beautiful but unfortunate *Psyche*, in which we had been wrecked on the 15th ult., and the weather in the Mediterranean had been so bad that it was impossible to leave Malta in time to rejoin the expedition before they left for England. Of detailed information, therefore, I have none.

In the first place, then, I submit that the fact that the corona is a compound phenomenon comes out in an unmistakable way. We have first of all a ring some 5′ or 6′ high round the moon, which almost all observers have seen alike; and then we have light beyond which some observers have seen of one shape and some of another, now stellate with many rays, now stellate with few, now absolutely at rest, now revolving rapidly.

This I think to be the key-note of all the observations with which I have become acquainted. I need scarcely say that it is exactly what had been predicted.

First among the fortunate ones who observed the corona with the telescope was Prof. Watson, of Ann Arbor, who took up his station at Carlentini, and appears to have been the best favored among the Sicilian observers. From his account I gather that there was an almost perfect *shell* around the sun about 5′ high, and that outside this shell were less definite rays. What he was particularly struck with was this, that, as seen in the telescope, the rayed portion was most developed over the prominences, and as I gathered from him in one case, the rayed portion was absent as if a veil had been removed; so that he, at all events, is strongly impressed with the idea that the shell represented a true solar appendage, and that the rayed structure was due to our own atmosphere.

Next comes Mr. Brett, who, although he was not so fortunate, still was enabled to see and place on record some most interesting features, including the whole outline of the corona and even some of the protuberances. He also, as I am informed, saw the rayed portion of the corona most developed above the protuberances, the outline of the interior portion being visible, though not so strongly marked as in the case of Prof. Watson's drawing, in consequence of less favorable atmospheric conditions. I am thankful to say that the weather at Syracuse enabled Mr. Brothers to obtain some admirable photographs, which I have not yet seen. These are among the most important results of the expedition.

Next I must mention Prof. Peirce, the head of one of the American parties, who observed two miles north of Catania, at a private casino of the Marchese Sangiuliano. I believe that he also saw the shell, but of this I am not absolutely certain; but he distinctly observed that the outer corona over the prominences was rosy red, although he did not see the promicences himself. A more beautiful proof of the terrestrial nature of this portion of the corona it would be difficult to imagine: for, of course, at the sun, the hydrogen, which thus tinged it, is incapable of coloring anything, as its own light is absorbed by the transcendent brilliancy of the photosphere; while nothing would be more natural than to suppose that the light, which, in its own atmosphere, should strongly tinge anything radially illuminated, should be that of the prominences.

But the strongest proof of the variability of the outer portion and of the constancy of the inner portion is afforded by the observations made on board the small fleet attempting to save the *Pysche* off Aci Reale, where the eclipse was observed in unclouded splendor. Here were the ironclads *Lord Warden*, *Caledonia* and *Royal Oak*, and the tugs *Weasel* and *Hearty*, besides the Italian gunboat *Plebiscito*, all within a stone's throw of each other. In all the drawings, and many have been received, we have a ring 5′ or thereabouts, while the outer portion is as variable as may be. On the same deck, that namely of the flag-ship, *Lord Warden*, two drawings were made, one by Capt. Brandreth, and the other by Dr. Macdonald, F.R.S., in which the variation is so strong that one would feel inclined to acquit the atmosphere of any participation in the matter, and to relegate the whole outer corona to subjectivity alone, did not Mr. Brother's admirable photographs show both phenomena, as I am told they do. Dr. Macdonald saw eight rays arranged with perfect symmetry; Capt. Brandreth saw only two elliptical hoops crossing each other at right angles.

Capt. Cochran, of the *Caledonia*, besides the ring, saw a complicated stellate figure, the rays of nearly equal length, while Mr. Dexter, at sea between Catania and Syracuse, saw, besides the ring, *only one ray* of inordinate length.

So much for the drawings. I think that if the records of former eclipses be now examined, especially Mr. Carrington's drawing of the eclipse of 1851, and compared with the others taken at the same time, additional evidence will be gathered in favor of the compound nature of the corona, which on the evidence now before me, I consider the great teaching of the present eclipse. Our experience in Sicily seems to be similar to that of the Spanish observers, for Mr. Perry writes that, "some observed two curved rays," while the rapid degradation of light occurred at one-fifth of a solar diameter, but, so far as I know, no one in Sicily was favored with a view of the dark intervals which were observed in Spain.

There is a strange and most interesting discordance between some of the spectroscopic observations made in Sicily and Spain. At Agosta, where the totality was well visible for ten seconds, Mr. Burton detected a green line near E, with a tangential slit (distance from moon not stated). This line, which was also seen by the Italian observers, is doubtless the one recorded last year by the American astronomers, but in Spain Mr. Perry states that bright lines at C near D, *b* (or E) and F were observed 8′ away from the sun. At Syracuse, Prof. Harkness, whose telescope was moved into the various positions by Capt. Tupman, R.M.A., found the green line in all parts of the corona, so far as about 10′ from the sun, and at one point thought he detected two green lines, less refrangible than it; but at several places he saw a complete hydrogen spectrum (including C) which he attributed to prominences, until he was informed by Capt. Tupman that there was no prominence near the slit. More proofs of the terrestrial nature of this portion of the corona, I think, taken in connection with the fact that *the dark moon gave identically the same spectrum.* It would appear that there was so much atmospheric reflection in Spain, and here and there at Syracuse, that the true coronal spectrum with its line near E, the existence of which we must now accept as established beyond all question, was partially masked by the prominent spectrum with its usual well-known lines. There is one passage in Mr. Perry's interesting letter in which, if there be a misprint, as I suspect there is, an observation of great importance is recorded. It runs, "Mr. Abbay, observing at Xeres with a spectroscope of 2 prisms of 45° belonging to Prof. Young, saw the bright lines, C, D, F; and afterwards F, and a line rather more bright than F on the less refrangible side of B, C not noticed then." Now, if *b* (not B) was intended here we have sub-incandescent dydrogen mixed with the green-line-giving-substance, which may probably be a new element with a vapor density less than hydrogen.

So that roughly we might regard the chromosphere to be built up of the following layers, which are in the orders of vapor density in the case of known elements:—

| | | |
|---|---|---|
| X′ (new element), | | Green coronal line. |
| Hydrogen | Sub-incandescent, | F. |
| | Incandescent, | C, F, near G, h. |
| X, (new element), | | Near D. |
| Magnesium, | | *b* and lines in blue and violet. |
| Sodium, | | D. |
| Barium, | | Several lines. |
| Iron, &c., | | Several lines including E. |

The foregoing table excludes naturally the substance or substances which give bright lines in the solar spectrum, which are at times visible in the spectrum of the chromosphere. I have ventured to suggest that the substance which gives the line in the green is a new element, because invariably I have found that in solar storms the chromospheric layers are thrown up in the order of vapor density, and because all the heavier vapors are at or below the level of the photosphere itself.

With regard to the question of polarization, the parties in Sicily obtained evidence that the corona was radially polarized, though Profs. Harkness and Eastman obtained a result which they explain differently. Mr. Raynard, at Villamonda, and Mr. Peirce, Jr., north of Catania, obtained identical results in favor of strong polarization. Hence the solar corona, accepting these observations, not only radiates, but reflects solar light to us. A careful consideration of this fact, taken in connection with the possible addition of a, so to speak, terrestrial corona to its light, may enable us to account for some of the observations, both polariscopic and spectroscopic, which do not at first appear to harmonize with those to which I have referred, notably those which give a pure continuous spectrum to the corona, and which state that its light is only slightly polarized.

From what has preceded, then, we seem justified in suggesting as working hypotheses the following, which, however, more accurate information may alter, and which I offer as suggestions only, *bien entendu.*

(1.) The Solar Chromosphere extends some 5′ or 6′ from the sun (Watson and others), its last layers consisting of cool hydrogen (Mr. Abbay), and possibly a new element with a green line in its spectrum (Young, Burton, and others); which line, if it be identical with the auroral line as stated by Gould, may possibly be present in the higher regions of our own atmosphere.

(2.) Outside this stratum the rays, &c., are for the most part due partly to our own atmosphere, partly to our eyes, for their shape varies; they are seen by some at rest, by others in motion, and their spectrum is the same as that of the dark moon (Maclear).

(3.) The white light of the chromosphere above the prominences, as seen in an eclipse, is due to its strong reflection of solar light, as shown by the polariscopic observations (Ranyard, Peirce, Jr., Ladd).

(4.) The rosy tinge of the corona proper, that is of the region more than 5 or 6′ from the sun, is due to our atmosphere containing light which comes from both the higher and lower strata of the chromosphere (Peirce, Sen., Maclear, Abbay.)

2. *Appendix to the Washington Observations of* 1868.—The Superintendent of the U. S. Naval Observatory, Commodore SANDS, has published the *Appendix I to the Washington Observations for* 1868, being a catalogue of 1963 stars, and a catalogue of 290 double stars, reduced from observations made at Santiago, Chili, during the years 1850, '51, '52, by the U. S. N. Astr. Expedition, Captain Gilliss, Supdt., Lieut. McRae, Master Phelps, and Captain's Clerk, L. R. Smith, Assistants.

The observations upon which these catalogues are based were intended to constitute vol. IV of the Report of the Expedition, but no appropriation has been made for their publication in full, though the manuscript is ready for the printer.

We heartily join Prof. Harkness in his introduction to the catalogues, in expressing the hope that it may yet be possible to procure sufficient funds to complete the reductions of the observations which were to constitute vol. V, the other unpublished volume of the report. These give the positions of 27,500 stars within 25° of the south pole. If the full observations could be published, it would be preferable. If not, a star catalogue deduced from them should be accessible to astronomers. H. A. N.

3. *Professor Young on the Eclipse.*—The letter from Professor Young, of Dartmouth College, an abstract of which is published on page 156* of this volume, in a postscript to the February number, was addressed (as was not stated in the Tribune from which it was cited) to Dr. Henry Morton, President of the Stevens Technological Institute, Hoboken.

## IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On Spontaneous Generation;* by E. FRANKLAND.—I have repeatedly subjected various solutions for Dr. Bastian to a temperature of 150° to 156° C. in sealed vacuous tubes, in order that he might afterward submit them to a microscopical search for living organisms. The result of this search led him to conclude that living organisms had been generated from non-organized matter, whilst Professor Huxley, who examined the contents of one of the tubes, considered that no such conclusion could be drawn from his own observations. I therefore determined to repeat these experiments, operating in exactly the same manner as before in the preparation of the solutions, the sealing them up in vacuous tubes, and exposing them to a high temperature, but taking additional and much more stringent precautions against the subsequent admission of atmospheric germs into the tubes.

For this purpose four tubes of hard Bohemian glass were prepared, and about half-filled with a liquid consisting of

| | |
|---|---|
| Carbonate of ammonia, | 15 grains. |
| Phosphate of soda, | 5 grains. |
| Distilled water, | 1 oz. |

No care was taken to exclude living germs from these ingredients, reliance being placed, for the destruction of their vitality, upon the high temperature to which they were afterwards subjected.

These tubes were carefully exhausted by means of the Sprengel pump, and hermetically sealed; they were then, on July 18, 1870, exposed for four hours to a temperature varying from 155° to 160° C. in a Papin's digester. After being allowed to cool, the digester was opened, and the tubes immediately plunged, two of them into colorless concentrated oil of vitriol, and the remaining two into a nearly colorless saturated solution of carbolic acid in water. These precautions were taken in order to avoid the possible admission of atmospheric germs through invisible cracks in the glass; such cracks, entirely invisible to the eye, are known sometimes to exist, and to be in some cases so excessively minute as to require several days for the admission of enough air to perceptibly impair a torricellian vacuum within. By keeping the tubes entirely immersed in liquids which are immediately fatal to vitality, I hoped to meet any objections that might be raised, in the event of living organisms being subsequently found in the tubes, that the germs of such organisms had gained access to the enclosed liquids through invisible fissures in the glass. On examining them when they came out of the digester, it was evident that the interior walls of the glass tubes had been corroded by the enclosed liquid, and as the tubes had stood upright in the digester, it was easy to see, by the sharp limits of the erosion, the extent to which the liquid had expanded under the influence of the high temperature to which it had been exposed.

The cylinders containing the immersed tubes were now maintained at a temperature from 60° to 75°F., and were exposed to bright diffused daylight, and sometimes to sunlight, for a period of more than five months.

The liquid in all the tubes became more or less turbid, and in some cases a small quantity of a light flocculent precipitate subsided to the bottom. On the 24th of December last two of the tubes, which exhibited the greatest turbidity, were selected for examination (one of them having been immersed in concentrated sulphuric acid, the other in the solution of carbolic acid). The vacuum was unimpaired, and the liquid in the interior formed a good water hammer. These tubes were opened in the presence of Prof. Huxley and Mr. Busk, and we submitted their contents to a searching microscopical examination with powers varying from $\frac{1}{8}$th to $\frac{1}{16}$th. Especially was the flocculent sediment in the tubes subjected to careful inspection. So far as the optical appearances presented by the sediment go, they may be appropriately described in the terms which Dr. Bastian applied to the matter found by him in a solution of like composition and similarly treated (see *Nature*, July 7, 1870, p. 200). "A number of little figure-of-eight particles, each of which was $\frac{1}{20000}''$ in diameter, were seen in active movement, even in situations where they could not have been influenced by currents. The portions of the pellicle were made up of large, irregular, and highly refractive protein-looking particles imbedded in a transparent jelly-like material. The particles were most varied in size and shape, being often variously branched and knobbed. There were also seen several very delicate, perfectly hyaline vesicles, about $\frac{1}{20000}''$ in diameter, these being altogether free from solid contents." But the movement of the particles which were observed was obviously mere Brownian motion; and many of the particles were evidently minute splinters of glass. There was not the slightest evidence of life in any of the particles. The water on the slide containing these solid matters was evaporated off, and they were treated with hot concentrated sulphuric acid, the temperature of the slide being raised to about 100° C. There was no blackening, and the rounded and dendritic bodies remained as entirely unaltered as the glass splinters. Indeed, some of the larger spheroidal bodies were evidently rounded particles of glass which had become detached from the inner walls of the tube by the corrosive action of the enclosed liquid at the high temperature to which it had been exposed in the digester.—*Nature*, Jan. 19, 1871.

2. *Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains;* by ROSSITER W. RAYMOND, U. S. Commissioner in Mining Statistics. Exec. Document No. 207, 41st Congress. 806 pp. 8vo. Washington, 1870. (Government Printing Office).—This Report treats with great fulness of the conditions of Mining Industry in all the various mining regions through the States and Territories of the far west, and is evidently the result of a vast amount of judicious labor on the part of the Commissioner, Mr. Raymond. Besides its two chapters of details on the mines, their history, conditions, methods of working, expenses, etc., and general reviews of the mining regions, it has chapters on the U. S. Mining Law; Mineral Deposits; and Metallurgical Processes; and 225 pages are devoted to a very valuable and well illustrated memoir on the *Mechanical Apparatus of Mining*, by Wm. P. Blake. The volume is one of great public importance, and should have a wide distribution through the land.

3. *Fall of rain at Hilo, Hawaii* (*Sandwich Islands*), lat. 19° 42′ N., long. 155° 5′ W.—The following statement of the fall of rain at a station on the Sandwich Islands, is put on record in this Journal, because the amount of rain is very remarkable, and because the number of stations within the tropics for which we have a record of the rain-fall, is quite limited. The observations were made by Rev. Titus Coan, missionary of the American Board, with a rain-gauge made by Prof. Chester S. Lyman of Yale College. The amount of rain for each day is recorded in inches and thousandths of an inch. The total amount which fell during the year was over 182 inches; and of this 90·7 inches fell in the night. The greatest amount which fell in any one month was

·156 inches, in March. The greatest amount which fell in one
y was 10·466 inches, on March 21st.

*Daily Journal of Rain at Hilo, Hawaii, from August* 1, 1846, *to July* 31, 1847.

| Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | March | April | May | June | July |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ·134 | ·639 | 1·085 |  | ·605 | ·400 | ·360 | ·620 | ·750 | ·025 | ·065 | ·130 |
| ·285 | ·030 | ·495 | ·325 | 1·975 | ·810 | ·692 | 3·045 | ·240 |  |  | ·060 |
| ·149 | ·340 | ·118 | ·240 | ·450 | 2·285 | ·140 | ·600 | ·845 |  | ·260 | ·110 |
| ·201 |  | ·155 | ·143 | ·010 | ·965 | ·300 | ·075 | 1·610 | ·720 | ·205 | ·125 |
| 1·034 |  | 1·475 | ·465 | ·260 | 5·895 | ·015 | ·140 | 4·355 | ·055 | ·015 | ·085 |
| ·155 |  | 4·290 | ·490 | ·025 |  |  | ·400 | ·285 |  | ·291 | ·355 |
| ·244 |  | ·953 | 2·065 | 1·740 |  | ·024 |  | ·015 | 010 | ·165 | ·080 |
| ·039 | ·015 | ·152 | 3·175 | ·293 |  |  |  |  | 3·980 | ·125 | ·950 |
| ·352 | ·015 | ·327 |  | 1·523 |  |  |  | 1·320 | 3·380 | ·035 | ·625 |
| ·399 | ·253 | ·330 | 1·700 | ·705 | ·225 |  |  | ·080 | ·100 | ·135 | ·530 |
| ·505 | ·042 | ·100 | ·650 | ·780 |  |  | ·020 | ·765 |  | ·195 | ·260 |
| ·395 | ·453 | ·220 | ·082 | ·789 |  | ·660 | ·960 | ·655 |  | ·145 | 2·170 |
| ·209 | ·438 | ·205 | ·007 | ·890 |  | ·050 | ·405 |  |  | ·040 | ·970 |
| ·309 | ·120 | ·020 | ·275 | ·217 | ·110 |  | 1·910 |  |  |  | ·070 |
| ·275 | ·010 | ·200 | ·080 | ·093 |  |  | 2·080 | 1·730 |  |  |  |
| 1·415 | ·200 | ·228 | ·805 | ·147 |  |  | 1·290 | 1·060 |  | ·500 |  |
| ·390 | ·103 | ·065 | 2·270 | ·001 |  | 1·245 | ·775 | ·965 |  | ·840 |  |
| ·555 | ·350 |  | ·810 | ·140 |  | 1·885 | ·045 | ·375 |  | ·130 | ·185 |
| ·022 | ·290 | ·005 | 1·025 | ·126 |  | ·830 | ·525 | 1·090 |  | ·265 | ·015 |
| ·346 | ·173 | ·122 | ·415 | ·035 |  | ·110 | 6·885 | 1·625 |  | ·635 | ·470 |
| ·490 | ·168 | ·031 | ·112 | 2·067 | 2·910 | 1·205 | 10·466 | ·075 |  | ·100 | ·325 |
| ·130 | ·228 | ·090 |  | ·735 | 2·420 | ·120 | 1·315 | ·390 |  | ·240 | ·510 |
| ·037 | ·101 |  | ·265 | ·228 | ·520 | ·590 | ·225 | ·435 | 1·500 | ·028 | ·055 |
| ·395 | ·150 | ·765 | ·805 | ·595 | ·680 | ·145 | 1·665 |  | ·050 | ·455 | ·519 |
| ·155 | ·100 | ·705 | 1·608 | ·525 |  | ·020 | ·170 |  |  | ·115 | ·105 |
| ·200 | ·100 | * | ·295 | ·090 | ·100 | ·325 | 1·050 |  |  | ·045 | ·155 |
| ·045 | ·010 |  | 3·565 | † | 1·125 | ·420 | ·350 | ·095 | ·365 | ·020 | ·070 |
| ·788 | ·235 | ·176 | 1·465 | † | ·050 | ·810 | 1·095 | ·080 | ·385 | ·135 | ·150 |
| ·613 | ·265 | ·105 | 1·550 | † | 1·505 |  | ·680 | ·050 | ·040 |  | ·085 |
| ·200 | ·135 | ·200 | ·755 | † |  |  | ·030 | ·025 |  |  | ·130 |
| ·183 |  | ·020 |  | † | 1·515 |  | 1·385 |  |  |  | ·625 |
| 10·685 | 4·963 | 12·643 | 25·442 | 13·937 | 21·515 | 9·946 | 38·156 | 18·865 | 10·680 | 5·256 | 9·919 |

* Gauge leaked. Total, 182,007 inches. †Record of these days lost.

4. *A short course in Astronomy and the use of Globes*; by
ENRY KIDDLE, A. M., Superintendent of Schools, New York,
uthor of a "New Manual of the Elements of Astronomy." New
ork, 1871. (Ivison, Blakeman, Taylor & Co.)—This little book,
190 pages, beautifully printed and illustrated, contains, in con-
se language, an outline of the elements of Astronomy, so pre-
nted as to make it a good text book for schools, especially in the
nds of teachers capable of supplementing its condensed state-
ents and explanations with suitable oral instruction. It appears
be accurate as to facts, clear in expression as its brevity per-
its, and conformed, in the main, to the latest and best authorities
the matters of which it treats.

## OBITUARY.

**William Chauvenet**, LL.D., Ex-Chancellor of Washington
niversity, St. Louis, died in St. Paul, Minnesota, 13 Dec., 1870,
a little more than fifty years of age. He had long been in poor
ealth, and on this account resigned his connection with the Uni-
ersity in 1869. After traveling in the South without the restora-

tion hoped for, he returned to St. Louis in June, and in the autumn went to St. Paul to try that climate; but his disease terminated at last in paralysis of the cerebellum. He was buried in St. Louis.

Chancellor Chauvenet was born in Milford, in northeastern Pennsylvania, and removed at an early age with his parents to Philadelphia. His father, William M. Chauvenet, was a grocer, and wished his son to succeed him in his business; he was with difficulty persuaded by his son's teacher to develop the boy's decided mathematical taste by a College course.

In 1836 he entered Yale College, and graduated with distinction in 1840. Immediately afterward he was employed under Professor Bache in taking meteorological observations at the Girard College Observatory, but resigned in 1841 to accept the position of instructor in mathematics at the U. S. Naval Asylum in Philadelphia. Shortly after, when it was proposed to found a Naval Academy at Annapolis, the measure found a warm advocate in the young Professor, and when the institution was established in 1845, he was made one of the Board of Directors, Professor of Astronomy and Mathematics, and Director of the Observatory. For the next fourteen years he was acknowledged as the chief agent in building up the Academy.

In 1859 he was elected Professor of Astronomy and Mathematics in Washington University, St. Louis, and at the same time was offered the professorship of Natural Philosophy and Astronomy in Yale College, where the chair of Mathematics had also been at his disposal a few years before. He accepted the professorship in St. Louis, and began his work there in the autumn of 1859. Three years later, on the death of his classmate, Chancellor Hoyt, the office of Chancellor of the University was also given him.

In addition to his professional labors, Chancellor Chauvenet was the author of several scientific works of recognized merit. The first was a text-book, entitled "Binomial Theorem and Logarithms." (Philad., 1843. 92 pp. 8vo). The standard character of his second work—"A Treatise on Plane and Spherical Trigonometry," (Philad., 256 pp. 8vo),—is attested by the fact that its sales were greater in 1869, nineteen years after its first issue, than in any previous year. In 1863 he published a "Manual of Spherical and Practical Astronomy," (2 vols. 8vo, pp. 708, 632, Philad.), the original and exhaustive character of which has been noticed by the late Professor Bond in this Journal, 2d series, vol. xxxvi, pp. 159, 378. His last work, on Elementary Geometry, written during his decline in health, was noticed in the last volume of this Journal.

Professor Chauvenet also furnished valuable contributions to this Journal, to Gould's Astronomical Journal, to the Proceedings of the American Association, etc. He was a collaborator in the preparation of the American Ephemeris and Nautical Almanac, for which he furnished tables for correcting lunar distances, a method of finding the error and rate of a chronometer by equal altitudes, etc.

He married, 30 Dec., 1841, Miss Catharine Hemple, of Philadelphia, who survives him with five of their six children.

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[THIRD SERIES.]

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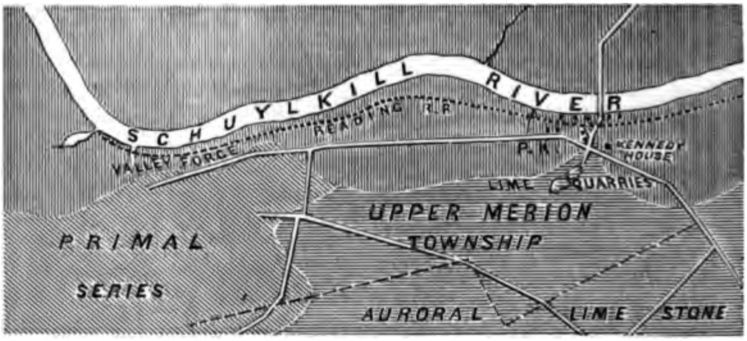
## ART. XXXIII.—*Notice of the discovery of a Cave in Eastern Pennsylvania, containing remains of Post-Pliocene Fossils, including those of Mastodon, Tapir, Megalonyx, Mylodon, etc.;* by CHARLES M. WHEATLEY.

THE remains herein described were recently discovered in what was at one time a *cave*, in the limestone quarries at Port Kennedy, Upper Merion township, Montgomery county, Pa., owned by John Kennedy, Esq., to whom I am indebted for the possession of the remains, and who has afforded me every facility for exploration and investigation.

The cave is in the Auroral Limestone of Rogers, regarded as the equivalent of the Black River and Chazy Limestones and Calciferous Sand Rock of New York, at its junction with the Mesozoic Red Sandstone and near a belt of the Primal series of Rogers, (fig. 1.) Caves of more or less extent have often been met with in these quarries; but most of them have been entirely worked away in getting out the stone for lime, and, as far as ascertained, none of them communicated with the surface, or contained any organic remains.

Recently, however, in cutting through the floor of a small cave, nearly the whole of the walls of which cave had been removed for lime, the workmen found a tooth. This tooth was brought to me by Dr. Quick of Phœnixville, as a tooth of the Mastodon. In company with him I immediately visited the locality, and found one end of the cave remaining, and having the form in a transverse section exhibited in figure 2. The width at the top is about twenty feet; below, it gradually expands to thirty feet; and then there is a rapid contraction downward, until, at a depth of about forty feet (B), it is ten feet wide. The whole of the space above this level is filled with the débris of the adjoining Mesozoic red shale, with occasional angular fragments of Auroral limestone, without any trace of organic remains. Where the cave narrows to ten feet (B) the floor is composed entirely of a black clay 18 inches thick, filled with leaves, stems, and seed-vessels of Post-tertiary plants. Scattered all through this mass of vegetable remains, and also in a red tough clay underneath, for six to eight inches in depth, are found the fossils noticed in this paper.

1.



Map of the region, showing the position of the Lime Quarries and cave; area lined vertically, is region of Mesozoic red shale; horizontally, of Auroral limestone; obliquely, of Primal sandstone.

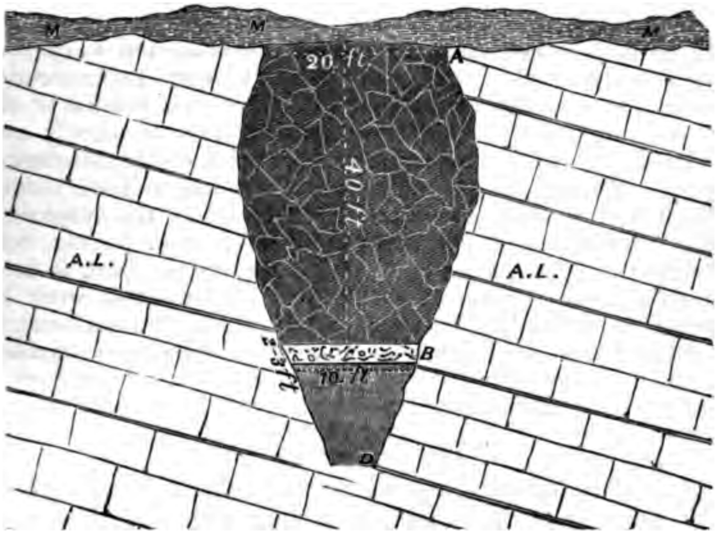
The Mastodon is *M. Americanus* of Cuvier. One of the teeth measures sixteen inches in circumference; the enamel is white or cream-colored, and well preserved. The *tusk* was uncovered for three or four feet in length, and was from five to six inches in diameter, but crumbled into fragments on being moved. The large bones are light cream color, much decomposed, but some of the articulations are very distinct.

In addition to the Mastodon and Tapir, Prof. E. D. Cope and myself have determined Sloths of the genera Megalonyx, and Mylodon, a large Artiodactyle, an Equine animal, and a large bear, the full size of the grizzly, besides other species mentioned beyond. This bear is entirely distinct in character from existing species of North America and the northern regions of the old world, as well as from the cave bear of Europe. It has been described by Leidy from a single molar from South Carolina, and if of the true genus Ursus, as is probable, will stand as *Ursus pristinus* Leidy.

The bones of Megalonyx are some of them in an excellent state of preservation; the claws and other bones of the feet especially are exceedingly perfect. Several canine and molar teeth of Megalonyx, 1¼ by 1¾ inches, with the cement and crowns perfect, have been found.

Of Mylodon both bones with claws and teeth have been discovered; also teeth and bones of a large Tapirus, the teeth of which retain their white highly-polished enamel. The bones of both Mylodon and Tapirus are dark-colored, and the bone-cells usually filled with iron pyrites.

2.



Section of cave and adjoining rock; M, Mesozoic shale; A, L., Auroral limestone.

There are rodents of the existing genera *Hesperomys*, *Fiber*, *Sciurus*, *Lepus*, &c. The reptiles are serpents, tortoises and batrachians of several species. A number of Coleoptera are fortunately preserved, several of them *Carabidæ*. Several species of birds occur, including a turkey, snipe, &c.

The remains of Mylodon, Ursus and Tapirus have been mostly obtained from the tough *red* clay directly under the plant bed, but the remains of rodents, snakes, tortoises, birds, plants and insects, are entirely confined to the *plant bed*. Neither the bones or teeth are rolled or water-worn, but all are sharp and well defined.

As far as our investigations have progressed, the cave has now afforded us the following species:—

**Mastodon Americanus Cuv., 1; Mylodon, 1; Megalonyx, ?2; Tapirus, 1; Equus, 1; an undetermined ruminant; an undetermined carnivore; Ursus pristinus, and another undetermined species, 2; ?undetermined Bat; Lepus, 1; Arvicola, 1; Sciurus, 1; Fiber, 1; Hesperomys, 1; ?undetermined rodents, 2; Coluber, 2; Tropidonotus, 1; Crotalus, 1; Cistudo, 2; Rana, 1; ?Turkey, 1; Snipe, 1; making in all, 27.**

**Vertebrates, 27; Coleoptera, 10; Plants, 10; total, 47 species.**

**Phœnixville, Pa., February, 1871.**

## ART. XXXIV.—*On the Geology of the Delta, and the Mudlumps of the Passes of the Mississippi;* by EUG. W. HILGARD.

[Read before the American Association at its last meeting in Troy.]

IN previous papers* read before this Association, I have communicated the results obtained during two successive geological expeditions to Louisiana, so far as the more ancient formations are concerned. It is the object of the present communication to present and discuss the phenomena of that portion of the territory explored by me, lying within what is usually considered the alluvial area proper, or Delta, of the Mississippi river. Most of these observations were made in 1867, during the first of these excursions referred to, under the auspices of the Smithsonian Institution; their publication having been delayed in consequence of want of time, on my part, to carry out the large amount of chemical and microscopic work involved in the discussion, which is even yet far from being as full as would be desirable. I hope, however, to be enabled, hereafter, to continue the investigation of the subject, both in the field and in the laboratory.†

### I. *The Upper Delta Plain.*

I recall to mind the fact that, as we descend the Mississippi, the older strata successively sink from view. A few miles below Vicksburg we lose sight of the older Tertiary. Thence down to the latitude of Tunica Bend, La., we find the rocks of the Grand Gulf (Tertiary) age, possessing but a very faint southward dip. Next, the oldest representative of the Quaternary epoch, viz., the stratified Drift or Orange Sand, disappears beneath the water's edge near Port Hudson; while the swamp, lagoon and fluviatile beds, which have given notoriety to the latter locality, are seen above high water level not much farther south than the city of Baton Rouge.

The gradual descent and successive disappearance of these strata is not, however, altogether a phenomenon of dip, in the usual sense, but in a great measure the result of consecutive deposition; while the *surface* slope of the Port Hudson deposits is manifestly in a great degree due to denudation, and in part, no doubt, to deposition on a sloping bottom. At Port Hudson as well as elsewhere, where extensive profiles can be seen, the deposits of that era exhibit the basin shape; both on the large and, sometimes, on the small scale. In this as well as in their lithological and paleontological features, they greatly resemble deposits now forming over large areas; and where the two are in juxtaposition, it is often difficult, sometimes impossible, to draw the line between them, since qualitatively their process of formation has been manifestly the same. Both above and below Port Hudson, and down as far as Fort St. Philip, the *apparently alluvial* river banks frequently exhibit at low water edge, solid blue clays, with cypress stumps and twigs imbedded therein, scarcely distinguishable from some materials occurring at Port Hudson, Côte Blanche, and other localities *of the Port Hudson age*; and as neither can be expected to contain any but living organisms, it is, thus far, from general considerations alone, that we can hope to deduce their real age. It might seem, at first sight, that the distinction is practically of little moment; but when it is considered that the Port Hudson deposits are separated in time from those of the present era, by a large portion of the "Champlain" period of depression, *plus* the entire "Terrace" period of elevation, it becomes obvious that the distinction is one of no little theoretical, and some practical, interest. For while the Port Hudson strata yield to the augur almost invariably a considerable rise of artesian water, no such result can usually be looked for in either river or delta deposits.

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* This Journal, II, vol. xlvii. Jan. 1869; Ibid., xlviii, Nov. 1869.

† For material assistance in the investigations embraced in this paper, I am especially indebted to the officers of the Delta Survey in charge of the Coast Survey schooner Varina—Messrs. F. P. Webber and Henry L. Marinden, for reports of observations and specimens furnished; to Capt. Day, in command of the same vessel, then moored at the Head of the Passes, for a boat's crew and personal assistance in the examination of the mudlumps; to Mr. Moulton, of the Cromwell line of steamers; to Captain Ed. Yorke, of the Towboat Association, and to Capt. Andrews, then of the dredgeboat at the Southwest pass, for free transportation on their respective vessels; and to Capt. Tilford and other gentlemen of the N. O. Pilot Association, for generous hospitality as well as much valuable information. For similar favors I am indebted to Dr. Copes, President of the N. O. Acad. of Sciences, as well as other members of that body. Other acknowledgments will be found in their proper places.

I think that a retrospective view of the geological history of the lower Mississippi Valley and Gulf Coast, as developed by my observations in the States of Mississippi and Louisiana, will serve to show the probability that by far the greater portion of what now constitutes the alluvial plain of the lower Mississippi is covered by the river deposits to a comparatively insignificant depth only; excepting where the ever shifting river channel itself has caused an unusual depth by excavation and subsequent filling up.

I have shown that toward the close of the Drift period, the place of the present Mississippi was occupied by what, but for its stupendous proportions, might be termed a torrent of fresh water, having, even as far south as the present coast line, a velocity sufficient to transport pebbles of five to six ounces weight, from localities not nearer than Tennessee and northern Arkansas; together with the smaller ones derived, doubtless, from the same sources as the drift boulders of Missouri and Illinois.[*]

In the bored wells of Calcasieu, these pebbles have been found as much as 450 feet below tide level; the inevitable inference being (provided the sea level remained constant), that, since the time of their transportation, the coast has suffered a depression to at least *that* extent—in matter of fact, probably, fully twice that amount.[†] The thickness of the drift stratum is about one hundred feet, the materials growing finer toward the top; indicating, therefore, a diminished velocity of the depositing current.

Overlying this sand and pebble drift, we find, as at Port Hudson, alternating strata of more or less lignitiferous clay and sand, 350 feet thick; a 130-foot clay bed lying on top. In its uppermost portion, this bed recalls to mind at once the variously colored clays of the Côte Blanche profile, with their calcareous concretions; but here, according to the concurrent testimony of the inhabitants and the microscope, *marine* shells take the place of the fresh-water fauna observed at the former locality. The sands which, on the whole, predominate in the lower portion, are readily distinguished under the microscope from those of the drift, by the predominant sharpness of the grains, and the occurrence of particles of lignitized wood; but I have not thus far succeeded in finding in them any other organisms. They resemble strikingly the materials obtained at corresponding depths in the bored wells in the city of New Orleans.

Few deep wells exist near the coast, in the interval between that city and the Calcasieu bores. In the only one of which I possess definite data, viz., at Salt Point on Bayou Salé, a bed of marine shells was found after passing through the first clay bed, at 60 feet.

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[*] Miss. Rep., 1860, p. 26 and ff.; this Journal, II, May, 1866; and Nov. 1866; Ibid. Jan.. 1869; Ibid. Nov., 1869.

The magnitude of this phenomenon would give it a continental significance even if it were confined to what I have termed the "Orange Sand delta," below Cairo. But as I have elsewhere stated, similar pebble streams, with slack water deposits of ferruginous sands intervening, exist in Texas; and I have the satisfaction of adding to the array of facts heretofore presented in connection with this subject, the testimony of Prof. Safford, of Tennessee; who, upon discussion, finds that the phenomena presented by the "Bluff gravel," "Ore region gravel," and "Eastern gravel" of this report, are most satisfactorily accounted for, and brought under a common point of view, upon the basis set forth in my publications, above referred to.

In connection with Tuomey's and my own observations in Alabama, and farther east, those of Prof. Safford acquire additional significance, and the southern stratified drift an additional claim upon the serious attention of American geologists. Compare Prof. Newberry's interesting paper on "The Surface Geology of the basin of the Great Lakes, and the Valley of the Mississippi," where it is stated that "no deposits, corresponding to the drift of the northern and western states, exist south of the Ohio river." (Ann. Lyc. Nat. Hist., N. York, ix, 213, 1869).

[†] This Journal, II, Nov., 1869, p. 335.

The same is true of the formation skirting the coast of Mississippi Sound. Deep wells there sometimes, though not always, strike beds of marine shells, and water possessing a considerable rise, after penetrating the uppermost clay bed; which *there* usually also contains cypress stumps, and forms the "blue clay bottom" of the Gulf coast. Sometimes, though rarely, deposits of marine shells, of living species, appear in the beds of streams. But so far as I know, their occurrence is limited to within a moderate distance from the general coast line; so that the great body of the formation underlying the upland parishes of East Louisiana, the Attákapas and Calcasieu prairies, as well as the coast-belt of prairies in Texas, consists of marsh, lagoon, and fluviatile deposits, with, probably, many an inlet or estuary of a more or less brackish or marine character.

Obvious as is the conformation of this littoral belt to the outline of the Gulf coast, the Mississippi valley influences it only in so far, as that its strata have here, probably, their highest absolute elevation,* and farthest extension northward. The latter circumstance is the natural consequence of the existence of the depression which, at least since the opening of the Cretaceous period, has determined the outline of the formations southward of Cairo—an embayment which, with every succeeding period of deposition, became less concave, until at the close of the Grand Gulf epoch, the concavity had all but disappeared. During the period of slow depression which characterized the Port Hudson era, the present general coast line must have been established; and, when upon the reversal of the movement of subsidence, the waters of the continent began to be discharged through what is now the lower Mississippi valley, the erosion seems to have been checked everywhere, save perhaps in the main channel, by the tough cypress swamp clay which now forms the immediate substratum of the lower littoral belt, and extends far into the waters of the Gulf.

It is incredible that the deposition which occurred along the whole Gulf coast from Indianola to Mobile, should not have taken place also in the main axis of the depression which, as the trend of the formations shows, had in a great measure been filled up. Yet, inasmuch as this was the deepest portion of the area, it is to be expected that here, if anywhere, marine deposits should extend far inland. We shall not, therefore, be surprised to find that, as Pourtalés has proven from the soundings made under the direction of Gen. Humphreys, the Mississippi river flows on marine beds, at New Orleans and Bonnet Carré. It would rather be remarkable if such beds should *not* appear even much higher up the river, since even in the comparatively insignificant valley of Pearl river, they have been met with in the latitude of Baton Rouge,* about 30 miles from the coast.

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* As regards the main body. At Weeks' Island and Petite Anse, and probably at Côte Blanche and Orange Island, their elevation exceeds that at Port Hudson bluff.

It is, doubtless, owing to the formation of these swamp deposits, and their subsequent resistance to denudation during and since the Terrace epoch of elevation, that the main body of the truly alluvial delta is thrown so far beyond the general coast line,† out into the Gulf. It is the shallow "blue clay bottom," so well known to navigators on the Gulf coast, which forces the great river to advance its mouths so rapidly toward deep water, by the accumulation of its own deposits; and the borings made at New Orleans have shown how slight is the thickness, even at such an advanced point, of the river deposits proper, overlying the older formation.

I owe to the active interest taken in this subject by Gen. A. A. Humphreys, U. S. A., an opportunity of examining, not only the specimens collected during the boring of the artesian well at New Orleans by a committee of the New Orleans Academy of Sciences (so far as they were preserved from destruction during the war); but also those obtained in the soundings made by the delta survey under his charge, upon which a very able and minute report of a microscopic examination had previously been made by Mr. L. F. Pourtalès. Upon the strength of the data furnished by the latter, as well as by the profile constructed by the committee of the Academy (reproduced in the "Report on the Physics and Hydraulics of the Mississippi river"), Gen. Humphreys concluded that at Bonnet Carré and New Orleans, the river flows on an ancient sea bottom, which he conjectured to be of Tertiary age. Sir Charles Lyell having questioned the correctness of this view, Gen. Humphreys obtained from the N. O. Academy as complete a suite of specimens of the borings as could be collected, and referred them to me for examination. The first results of this investigation are given, in substance, in the first volume of Lyell's Principles of Geology, 10th edition, p. 459; they were based substantially upon the determination of the visible shells (mollusks) contained in several of the specimens, embracing, fortunately, most of the important horizons mentioned in the profile. I have since gone over the whole ground, in the microscopic examination of all the available specimens, with a view to determining their (marine or fresh water) character, and the admissibility of the supposition that they might belong to the delta formation proper.

My detailed report of this examination will, I presume, be published before long.‡ Unfortunately, most of the specimens resenting the important clay strata (of 34, 32½, 39, and 63½, t respectively), were missing; but as regards the rest, 51 in nber, I found almost all derived from a lower level than 31 , either characterized by marine organizations (shells, corals foraminifera), or of such a character as, by their obvious con- tion with the others, to put them in the same category, hough devoid of fossils. I cannot omit to mention in this nection, the extraordinary scarcity of marine organisms in ne of the specimens brought up in sounding *off*, *on* and *inside* bars of the Mississippi passes; the most patient search, n after concentration by washing, having failed to bring light anything but minute fragments of wood, root and er vegetable fibers, and remnants of Naviculæ. These cimens had, it is true, been obtained during a period of high ter; and others, collected at corresponding points, but at a ferent season, showed abundance of foraminifera, and even ne visible shells. But in view of these facts, it is quite in- ligible how in an estuarian formation, forming at the outlet the continental waters, many portions may have remained stitute of any vestige of marine life, though perhaps deposited strongly brackish water; while any slackening in the rate of pression would promptly cause a predominance of the fresh er the salt water, a stagnation, and consequent deposition of ys; which would be nearly or quite free from vestiges of rine life. Such is the case in *some* of the few clay specimens m this bore, which I have had the opportunity of examin- ; but others I have found to contain not only foraminifera, t abundance of shells. In the clay occurring at the greatest pth reached—630 feet—Mr. Pourtalès reports an abundance foraminifera.

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* Miss. Rep., 1860, p. 156.

† Drawn, say from the mouth of Pearl river to Belle Isle, the most advanced outpost of the Port Hudson deposits on the Louisiana coast; which line will pass near the city of New Orleans.

‡ In Rep. of the U. S. Engineer Dept., for 1870.

The specimens from the several beds contained altogether out 50 species of mollusks, of which 40 were in such a con- ion as to be determinable with certainty. Of these, 36 were cies now living in the Gulf, and 4 were new.

The latter (belonging to the genera *Cardium*, *Abra*, *Semele* l *Tapes*) I submitted to Mr. Conrad for determination and cription. He remarks that while they (one of them espe- lly) seem to be rather of Miocene type, and not known to be w living in the Gulf of Mexico: yet our knowledge of the na of the latter is so imperfect thus far, that it cannot be as- ted that the species are not now inhabitants of the Gulf ters.

As regards the distribution of the species, there is no mate- l difference from the highest to the lowest level, the leading l predominant species being everywhere about the same, and nciding in a marked manner with the fauna collected by self on the beach of Ship Island in the Mississippi Sound;

though quite different in the prevalence of species, from that now cast ashore on the islands of the delta. One of the new species, moreover, occurs abundantly in one of the very first shell-beds; and three of them at the depth of 235 feet, as well as, in part, still lower down.

In view of all the facts bearing on the case, the most probable conclusion is that the marine formation penetrated in the New Orleans well is altogether independent of the present delta formation; that, on the contrary, it is the equivalent in time of the Port Hudson deposits, which everywhere near the coast assume a marine facies; and would necessarily possess that character in an increased degree, where the deepest depression existed.

The thickness of the alluvium proper in the alluvial plain will, of course, vary in accordance with the degree of denudation that the older formation may have experienced during the era of upheaval; and it is futile to attempt an estimate of the amount of alluvium deposited by the great river since the beginning of the modern era, until numerous observations shall have placed us in possession of data, allowing us to form an approximate estimate of its depth in the several portions of the alluvial plain. While there exist in it, doubtless, a number of ancient river channels, we already have proof also, of the existence of ridges of more solid and ancient ground, far out in the delta plain, which seem to have caused the eastward deflection (parallel to the Tèche and the main Mississippi), of Bayou Lafourche as well as of the minor channels. I have heretofore* alluded to the apparent *general* cause of this deflection, viz., the barrier of drift materials accumulated, perhaps, upon a Cretaceous nucleus, which is presented by the chain of Five Islands—Belle Isle, Côte Blanche, Weeks' Island, Petite Anse and Orange Island—extending from Atchafalaya to Vermilion Bay.

The very variable depth of the alluvium is well exemplified by the borings made for water and gas, in the City of New Orleans, by Mr. J. B. Knight, of that city. Its lower limit seems to be almost everywhere marked by a stratum of liquid mud, beneath which appears the first shell bed. It is from this mud stratum, which is struck at depths varying from 31 (in the well of 1856) to 56 feet, that combustible gas is frequently found to issue in considerable abundance, and with a pressure (as reported by Mr. Knight) of from 1½ to 3 pounds per square inch. The discovery (which was made by Mr. Knight in boring an experimental well for water, on his premises) at first created considerable excitement, as it was thought the natural gas might successfully compete with that of the gas company, which it was said to equal in quality. That this was but an indifferent compliment to the company's product, may be judged from the composition of the natural gas, which was analyzed by Prof. J. W. Mallet, then of the University of Louisiana, with the following result:

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* This Journal, II, Jan., 1869, p. 88; ibid, Nov., 1869, p. 343.

*Gas from "Knight's well,"* 170 *Gravier street, New Orleans.*

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| Marsh gas, | 91·81 |
| Carbonic acid, | 2·97 |
| Nitrogen, | 5·32 |
| Hydrocarbons condensible by bromine, | trace |
| | 100·00 |

The gas issued at the rate of one and a half cubic feet per hour, with a pressure of 1·6 inches of mercury. It was reached at a depth of 40 feet, and was accompanied by a considerable flow of faintly saline water.*

Mr. Knight sunk numerous wells in different portions of the city, and states that gas was struck nearly everywhere at depths varying from 37 to 56 feet; its amount, in one and the same region, being sensibly proportional to the diameter of the bore. In a few cases, an extraordinary amount of gas, under strong pressure, was struck. In an article published in the New Orleans Times, of March 19, 1870, it is stated that "at the old Washington Artillery building on Girod street, a pipe was driven for water, and the gas flowed through in such a volume, that when ignited it fed a flame 15 feet in height, which was with difficulty extinguished; and when it was at length choked out, it carried up several cart loads of sand in a single night. Yesterday a similar phenomenon presented itself on the edge of the sidewalk in Camp street, opposite Lafayette square. A pipe about an inch and a half in diameter had been driven into the ground for water, when at the depth of 60 feet, a rush of gas, accompanied by water and sand, was forced through to a distance (height) of twelve or fifteen feet above the top of the pipe. This continued for two hours, in spite of all efforts to suppress it; and the result was a deposit of sand mixed with fine shells and pebbles, amounting to at least three cart loads. Finally the workmen succeeded in closing the pipe, and forcing it through the gas-bearing stratum."

The supply of gas was in the end, however, thought inadequate for practical purposes; while the original object of obtaining drinkable water was attained to a limited extent only. Mr. Knight says in a letter on the subject, that he has "found great irregularity in the thickness and character of the strata, and it is impossible to tell the character of the water or the depth at which it will be found, before trying. At two places distant about 1,500 feet, I obtained, in one, at the depth of 48 feet, a free supply of clear water strongly impregnated with iron; in the other, no such water could be found at the depth of 78 feet."

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* See analysis beyond.

Attention having been called to the subject, a "find" of gas was next reported from the parish of Lafourche, said to rise with a pressure of 10 pounds to the inch. I have been unable to learn whether or not this occurrence of gas is identical with that described to me by Col. Thibodeaux, of Thibodeauxville, as keeping up a continual agitation of the waters of the "Bayou bouillant," on the lower Lafourche. So far, no practical application of this source of gas has come to my knowledge.

As regards, then, the upper delta plain, there can be little doubt that, like the Calcasieu and Attákapas prairies, it is underlaid by the detrital deposits of the stratified Drift, at a depth which may fairly, *à priori*, be supposed commensurate, in a measure, with the importance of the neighboring channels; viz., the Sabine on one hand, and the Mississippi on the other. About midway between, the Cretaceous ridge, marked by the line of outliers from Lake Bisteneau to Chicotville or Petite Anse, has caused these same deposits to appear at the surface.* The overlying swamp, lagoon and estuarian deposits of the Port Hudson age, will vary both in thickness and in the (marine or fresh-water) character of their materials, in accordance with the conformation (relative to the ocean) of the surface upon which they were deposited. And the alluvial deposits proper will, in like manner, vary in thickness in accordance with the degree of denudation previously experienced by that older formation, but appear to be little greater on the alluvial plain near New Orleans, than it is sometimes found to be in the Yazoo and Tensas bottoms.†

It is important to note that, under this point of view, the ultimate success of an artesian bore at New Orleans becomes a matter of certainty—a question of depth alone. All water obtained in the Port Hudson strata possesses considerable rise, but is usually too strongly mineral to be desirable for every-day use. The waters obtained in the Orange Sand, on the contrary, are always remarkably pure, and when struck *beneath* the Port Hudson deposits cannot fail to possess a proportionate rise, as in Dr. Kirkiman's bore, on the West Fork of Calcasieu. The waters of the Port Hudson strata would, of course, require to be tubed out.

[To be continued.]

* This Journal, II, Nov., 1869, pp. 332, 342 and ff.

† Humphreys and Abbot's report, pp. 98–100, et al.

## RT. XXXV. — *Contributions to Physics from the Lawrence Scientific School.*—No. 1. By S. P. SHARPLES, S.B.

### *On some forms of the Galvanic Battery.*

WHILE making some experiments as to the best method of termining nitrous acid, Dr. Gibbs had his attention called to e fact that nitrous acid is instantly oxydized by an acid solu- n of potassic bichromate to nitric acid.

This result he communicated to me in the early part of 1870, ying, at the same time, that he thought it might be advanta- ous to use a mixture of nitric and sulphuric acids and tassic bichromate, as the absorbing liquid in the porous cell the Bunsen battery. The chromic acid would prevent any olution of nitrous acid by oxidizing it as soon as formed to tric acid. The nitric acid being the active fluid in the com- nation would prevent the polarization which is continually king place in the ordinary bichromate battery, and would be nstantly renewed.

Having occasion to use a battery, a few days after, I tried e mixture with such satisfactory results that it seemed desi- ble that the subject should be more fully investigated. The ectro-motive force and internal resistance of the battery were erefore determined.

The apparatus used was one of Poggendorff's rheostats, which as furnished with sixteen meters of German silver wire, the sistance of this being but little affected by changes of tempera- re. By means of clamps, any number of centimeters of wire uld be introduced into the circuit. When the needle of the lvanometer was deflected to forty or fifty degrees a change of e centimeter in the length of the resistance could be readily en. The galvanometer was an ordinary one in which the coil as replaced by a broad, thick, copper band, passing once ound and close to the needle, which was suspended by a fila- ent of silk and so adjusted that it was at the zero of the scale hen it came to rest in the meridian.

In order to determine the internal resistance, I made use of o elements of the same construction, which could be thrown to the circuit either singly, or side by side. I found when all y connections were bright, that there was no appreciable dif- rence between the two elements, that is, either element when nnected with the galvanometer would deflect it the same mber of degrees.

The zincs were about four inches high, and two and a half ches internal diameter, with a slit in one side. The porous ps filled the internal space almost entirely. The carbons used were those manufactured by Chester of New York for ordinary medical batteries and had a section of about a square inch. The exciting liquid was a mixture of sulphuric acid with nine times its volume of water; this was found to be without action on the zincs when the battery was not running. The zincs were kept well amalgamated.

The electro-motive force was determined by Wheatstone's method,* as follows: One of the cells was thrown into the circuit; the rheostat was then adjusted until the needle stood at 40°; the resistance was then decreased, until the needle rose to 50; the length of wire removed was noted. The second cell was then placed by the side of the first and the resistance increased until the needle again stood at 50°, and the added length of wire noted. While both cells were connected the needle was brought again to 40°, by removing part of the resistance, this length was also noted; it should correspond exactly to the first length. One of the cells was then removed and the resistance again adjusted; the wire removed should exactly equal the second length noted above. The second cell was now substituted for the first, and if the needle still remained at a constant point, the measure was considered satisfactory. If there was any discrepancy in the measurements, or if the needle stood at a different point with one cell, from what it did with the other, the connections were all examined and the measurements repeated. It was rarely found necessary to make more than one trial.

The formulas used were those given by Wheatstone (loc. cit.), as follows: For electro-motive force $\frac{E}{E'} = \frac{l}{l'}$ in which E = the electro-motive force of a standard battery, and *e* the length of wire necessary to reduce the needle of the galvanometer from one given point to another given point. E′= the electro-motive force of the battery to be determined, and $l'$ the length of wire which was required to be removed to change the needle from one of the given points to the other.

For the internal resistance of the battery, $R=2l$, in which formula R= the internal resistance, and $l=$ the length of wire which must be added when a second cell is placed by the first to bring the needle to the same point where it stood when only one cell was in circuit. After making one series of measurements, the needle was brought to 40°, and allowed to remain at that point for twelve hours if the battery remained constant for that length of time; the measurements were then repeated, and compared with those of a Bunsen cell made under the same circumstances.

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* Phil. Trans., 1843, Part II, p. 313.

The first measurements, made in March, 1870, were merely to determine the electro-motive force. In the rest of the experiments, made in December, 1870, and Jan. 1871, the internal resistances were also determined.

1*st Experiment.* For purposes of comparison, a Daniell's cell was fitted up, using the same zinc and porous cup, and the same exciting liquid, but substituting for the carbon a hollow cylinder of copper open at one side and using a saturated solution of cupric sulphate as the absorbing liquid. The mean of six comparisons of this with a Bunsen's cell gave 169 for the electromotive force of the latter, that of Daniell's being 100. Latimer Clark* gives the number 175.

*Ex. No.* 2. The porous cell was filled with a saturated solution of potassic bichromate in a mixture of equal parts of nitric and sulphuric acids, diluted with four times their volume of water. This gave a constant battery working without giving off acid fumes until the exciting liquid was exhausted. Its electro-motive force was the same as that of the ordinary Bunsen cell.

*Ex. No.* 3. The porous cell was filled with coarse fragments of potassic bichromate, and then saturated with nitric acid. The electro-motive force was the same as in the last experiment, but the battery was not quiet so constant, and there was a great waste of bichromate, there being much more than was requisite to saturate the nitric acid.

*Ex. No.* 4. The cell was filled as in the last experiment, only the liquid used was a mixture of equal parts, nitric and sulphuric acids. The electro-motive force was the same, but trouble was experienced from the formation of crystals of chromic alum which encrusted the carbons and porous cells and stopped the working of the battery.

*Ex. No.* 5. The absorbing liquid was a saturated solution of potassic bichromate in hydrochloric acid. The electro-motive force of this battery rapidly declined; starting with the same force as Bunsen's, in the course of 2½ hours it ran down to two-thirds of that force; its internal resistance at the start was 1·7 that of Bunsen's; at the end of 2½ hours it was 3·6. It gave off chlorine during the whole time it was in action.

*Ex. No.* 6. The absorbing liquid was a saturated solution of potassic bichromate in nitric acid. It gave the same electromotive power as the ordinary Bunsen cell, but the internal resistance was about 2·3 as much. The battery was sensibly constant for twelve hours.

*Ex. No.* 7. Ex. No. 1 was repeated under slightly different circumstances. The saturated solution of bichromate, used in the last experiment, was mixed with ¼ its own volume of strong sulphuric acid, and enough water added to take up the precipitated chromic acid. This formed the most satisfactory battery tried; it was perfectly constant during twelve hours. The internal resistance was only about 1½ times that of an ordinary Bunsen's cell of the same construction, and not the slightest odor could be perceived in the room. The electro-motive force was the same as that of the Bunsen cell.

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* On Electric Measurements, p. 108.

*Ex. No.* 8. Having seen in the American Chemist* a notice of a new battery by Prof. Bunsen, mentioned in an address by Prof. Roscoe, before the Chemical Section of the British Association for the Advancement of Science, I made a trial of it. This battery consisted of two metals, platinum and zinc, with a single fluid, namely, a solution of chromic acid in dilute sulphuric acid; I tried it in a small cell in which equal surfaces of zinc and carbon were opposed to each other. The electro-motive force was twice that of a Daniell's cell, or 1·2 that of a Bunsen's; but it was not very steady, and the chromic acid acted strongly on the zinc.

*Ex. No.* 9. Dr. Gibbs suggested to me to try a solution of chromic acid in nitric acid in the porous cell, using sulphuric acid in contact with the zinc. The electro-motive force was the same as in the last experiment, and the internal resistance was the same as in the Bunsen cell. The battery was perfectly constant. Two cells very slowly decomposed pure water and gave vivid flashes of light when the connections were made.

*Ex. No.* 10 was undertaken to determine the effect of replacing the bichromate by manganic oxide. The porous cell was filled around the carbon with manganic oxide; nitric acid was then poured on it until it was completely saturated. This gave very poor results; the electro-motive force was about 1·43 times that of a Daniell's cell. The battery was not very steady, and after running some time began to give off fumes of nitrous acid.

*Ex. No.* 11. Joule† gives an experiment with a battery in which platinum in nitric acid is used as the negative, and zinc in caustic potassa as the positive electrode, and gives the electro-motive power as equal to 2·41 Daniell's. I repeated the experiment, using a solution containing ⅕ of its weight of potassic hydrate in the outer cell, and a saturated solution of chromic in nitric acid in the inner cell. I found the electro-motive force at first about 2·35 that of Daniell's cell, the internal resistance being that of a Bunsen's cell. It was rather unsteady at first, and then began to gradually decline. No odor was perceptible.

Several experiments were tried, with the hope of obtaining a single fluid battery with the following results.

*Ex. No.* 12. A strong solution of caustic potassa was made, saturated with ferricyanide of potassium and used in the cell employed in experiment No. 8. This gave a feeble current and the carbon was rapidly polarized.

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* Vol. i, p. 209.

† Phil. Mag., vol. xxiv. p. 113, 1844.

*Ex. No.* 13. As solutions of sulphurous acid and acid sulphites dissolve zinc without evolution of hydrogen, forming hyposulphites, it was thought that these might be used as the exciting liquids. They gave a very feeble current and the carbon was soon polarized; the sulphite of zinc formed also adhered to the zinc and prevented further action.

*Ex. No.* 14. Iodide of potassium saturated with iodine was tried; this also gave a feeble current and the carbon soon became polarized.

*Ex. No.* 15. A cell of the Maynooth battery was fitted up and a saturated solution of potassic bichromate in nitric acid used as the absorbing liquid; the battery was not very constant, and the iron was soon attacked; no fumes, however, were given off The electro-motive power was about ·55 of a Daniell's cell.

The result of these experiments seem to show that the battery used in experiment No. 7 is the best for ordinary use, since it costs but little, if any more, than the Bunsen battery charged with nitric acid alone, and is entirely free from fumes until exhausted. If the following directions are observed in preparing the fluids, it cannot fail, I think, to give satisfaction.

To prepare the exciting liquid, sulphuric acid of 1·84 sp. gr. is mixed with nine times its volume of water and allowed to stand until the precipitated lead has all settled. The clear acid is then decanted and is fit for use. This plan of preparing the acid has been in use in this laboratory for some years and gives very good results, local action being almost entirely prevented by the removal of the lead.

To prepare the absorbing fluid, ordinary commercial nitric acid is saturated with potassic bichromate; this should be done in a warm room, as it takes up much more when warm than when cold. The solution thus prepared is mixed with one-third of its volume of sulphuric acid and enough water added to re-dissolve the chromic acid precipitated.

Two objects are gained by adding the sulphuric acid. The mixture is less expensive than if pure nitric acid is used and the internal resistance is decreased. If the internal and external cells are properly proportioned this battery will run until the exciting fluid is exhausted, without giving off any fumes of nitrous acid. If crude chromic acid could be obtained at a sufficiently low rate, No. 9 would be a very powerful and convenient battery for many purposes.

My thanks are due to Dr. Wolcott Gibbs for many valuable suggestions made during the progress of this investigation and for the use of the apparatus employed.

Cambridge, Jan. 17, 1871.

## ART. XXXVI.—*Notes on the Geology of Santa Domingo;* by WM. M. GABB.

ALTHOUGH the geological survey of the Republic of Santa Domingo has now been in progress about two years, nothing has been made public of our results, and I had not intended to publish anything until its completion. But circumstances now transpiring render it advisable that I should put on record at least a sketch of the principal conclusions arrived at.

The Republic is of a very irregular triangular shape, nearly twice as long east and west as from north to south. The total area is about 20,000 square miles. Running nearly through the middle, with a direction a little south of east, is a high chain of mountains, some peaks reaching a height of 9,000 feet. This range falls to the eastward, forming ultimately a chain of hills which runs parallel with the southern border of Samaná bay. In some places it is hardly ten miles wide, in others (near the middle) it reaches a width of nearly forty miles, including its greater spurs. South of this range, bordering the coast, is a tract, partly of rolling hills, partly of plains, which, especially in the large peninsula at the eastern end, constituting the Province of Saybo, are broad grassy prairies, cut up by lines of trees, filling depressions and bordering water courses.

Parallel with this great range and bordering the north coast is another mountain chain, neither so broad nor so high as the first. This extends from Manzanilla bay, almost on the Haytien frontier, to the extreme end of Samaná peninsula. It is cut through, near the head of Samaná bay, by a narrow belt of marsh land, through which runs a salt water creek, thereby making Samaná really, an island. This range has a few peaks rising to 2,500 or 3,000 feet and is nowhere much over ten miles wide. Between the two mountain chains lies a long valley having an average width of ten or fifteen miles, in some places much wider, in others, encroached on by the foot-hills of the mountains on its south. The valley is divided near its middle by a water-shed, but 500 feet above the sea. The Yaqui and Yuna rivers, rising in the higher hills south, run through this valley, the former emptying into Manzanilla bay on the west, the latter into Samaná bay on the east. On the south side of the island are several large rivers which run from the same mountain southward. The principal of these are the Macorio, Ozama, Jaina, Nigua, Nizao, Ocoa and Neyba, the last sometimes called the Yaqui of the south, rising in the same peak as its northern namesake.

Having thus described the leading topographical characteristics as concisely as possible, we can more easily explain the geological features which are intimately connected with them.

The great central chain of mountains consists of an immense cone of syenite and syenitic rocks, evidently of later date than the metamorphic strata that flank it. This mass is probably, in some places, as much as fifteen or twenty miles wide, though its southern and southwestern borders have not yet been explored, lying as they do in the Province of Azua, to which our labors have not yet extended. In this Republic it makes its appearance on the borders of Hayti, about fifteen miles south of Manzanilla bay, and from here makes all of the higher range of central mountains, to a point just about due northwest of Sta. Domingo City, or in other words, the center of the Republic; there its northern boundary suddenly bends south, becoming the eastern, the mass making a tongue eighteen to twenty miles wide, running a little east of south, to a point about twenty miles from the coast and nearly north of Bani. From analogical reasoning, based on the character of its northern margin and the peculiarities of the topography, it is almost safe to predict, that north of Banica and San Juan, or in other words in the mountains of the north-west, it will not have a much greater width than the strip above Bani. This mass of crystalline rocks has pushed up, tilted, folded, and in some places sent complicated net works of dikes into the overlying strata. Some of the dikes extend miles from the parent mass, and are of all sizes from 100 feet and upward, down to a thread.

The lithological characters of the syenites are not so variable as might be anticipated over so wide an area (say 20 by 100 miles). The rock is usually a light gray, moderately fine-grained mixture of the ordinary constituents, quartz, feldspar and hornblende, in nearly equal proportions, though sometimes the latter mineral makes up almost the entire mass, in the shape of large crystals, and more rarely it is almost entirely absent, and still more rarely a little mica occurs. No gneiss has been observed, but two or three localities of mica slate have been found, and one or two erratic pebbles have been discovered composed of quartz and feldspar only.

Overlying the syenite, and as stated above, uptilted by it is a heavy deposit, several thousand feet thick, of conglomerates, jaspery and magnesian slates, with a little limestone. These are almost invariably metamorphosed to such an extent as to have entirely destroyed their original character, and often, even their stratification. In the country west of Bani, both about the lower Ocoa and farther north, the shales are so little altered that they can be recognized as fissile clay shales, in a few cases giving rise to salt springs, but in no case fossiliferous. I was fortunate enough, at one locality on the Nigua, to discover a small locality in the limestone, almost unaltered and with a few fossils, usually poorly preserved. I succeeded in obtaining a little *Ammonite*, a *Trigonia*, a *Pterocardia* shell, besides a few less characteristic genera, and what may prove to be a *Baculite!*; thus fixing the secondary and possibly the Cretaceous age of the oldest stratified rocks on the island.

These rocks form a border to the crystalline cone, and extend to the eastern end of the island forming its "backbone." On the borders of the syenite, it is often cut by veins of auriferous quartz, and elsewhere it contains unimportant deposits of copper, and in one locality, iron.

In the neighborhood of San Cristobel, twenty miles west of Sta. Domingo, and extending as far west as we have explored, are small isolated basins of the next formation. This obtains its greatest development on the north side, but is said also to fill a depression extending to Port au Prince. I refer to the Tertiary rocks, which play an important part in the geology of the Island. They lie unconformably on the edges and flanks of the secondary deposits, fill all of the great northern valley of the Citao, and constitute the northern chain. In the northern foot-hills of the central chain, these rocks come in as a thin edge, gradually thickening as we descend into the valley, and eventually acquire a thickness of perhaps 1,500 or 2,000 feet. They consist of conglomerates, sandstones, gray, blue, brown and white shales, argillaceous and pure limestones, the rocks being enumerated in an ascending series from the conglomerates upward. Fossils are found throughout the series, though usually rare except in the blue and brown shales where they are sometimes very abundant, and in an extraordinarily beautiful state of preservation. There have been enough fossils found in all the beds, from base to top, to settle the question, that no line of demarcation of age can be drawn in the series. The species have not been sufficiently studied, by me, to enable me to express a positive opinion as to the part of the Tertiary group to which they belong. Messrs. Geo. Sowerby (Quart. Jour. Geol. Soc., London, 1849, p. 44), and J. Carrick Moore, (*loc. cit.* and Quart. Jour., 1853, p. 129), consider them, for good reasons given, to be Miocene, in which opinion I am inclined to concur; while Mr. T. A. Conrad, whose acquaintance with the American Tertiaries is greater than that of any other person, says they are Oligocene.

In the valley of the Cibao these beds are but little disturbed, at most being but slightly undulated; but in the northern range of mountains they are in some places highly uptilted, in one locality being vertical, but were much folded. The coal mines reported to exist in Sta. Domingo are merely the beds of lignite in the shales of this group.

It is proper here to call attention to an article in the Quart. Jour. Geol. Soc. 1853, p. 115, *et seq.* by a Mr. T. S. Heneken, illustrated by a map and several sections. I do so because the above description is totally at variance with the article quoted, and these examinations were made with a full knowledge of the statements of Mr. Heneken. I make this explanation, not from any feeling of antagonism, and may mention that the author died several years ago on this island; but a regard for truth requires me to state that the descriptions there given of the geology of the Cibao are, at least, very extraordinary. Among other things, he has taken a part of the Tertiary sandstones, erected them into an older formation, and states, incorrectly, that it underlies unconformably the blue fossiliferous shales. Another important inaccuracy is his assertion that the north range, at Mt. Muraso, is an anticlinal of older rocks (see fig. 3, p. 119, *loc. cit.*); whereas it is really the newer part of the Tertiary deposit, lying at low angles, the anticlinal being far north of the summit of the mountains. The errors arose without doubt from the inexperience of the observer.

Bordering almost the entire coast, from Manzanilla bay, around the eastern end of the island to the north of the Nizao river, on the south side, is a deposit of horizontal limestone of very modern origin, in places full of living corals and very imperfect casts of living species of mollusca, but more usually, where not hardened by the weather, a white or cream-colored friable limestone, the result of the breaking down or decomposition of coral. It rarely makes bluffs on the coast of more than 20 or 30 feet in height, but has been penetrated by wells between 150 and 200 feet deep without passing through it. This border has a variable width of from a few hundred yards to many miles, and in the neighborhood of Sta. Domingo City, where it is a dozen miles wide, it illustrates beautifully the phenomenon of change in lithological character of the same beds. Toward its margins in this vicinity near what was at that epoch the mouth of the Jaina river, a few pebbles begin to appear, unmistakably attributable to the hills of the upper Jaina. Proceeding northward, or toward the former coast, these pebbles become more numerous and the lime less pure, until eventually the same stratum can be traced into a common shore gravel, evidently the product of the river, and without a perceptible trace of lime. Further; in going east from the neighborhood of the Jaina, but along the ancient coast, the pebbles again disappear and the shore margin of the deposit becomes, as might be anticipated, sand; while farther out the limestone belt continues in the position of the former reef.

No volcanic rocks have been encountered in the course of our explorations except in the mountains north of Bani, where we found a single dike of black porphyry with large white crystals of feldspar.

## ART. XXXVII.—*On Spore-cases in Coals;* by J. W. DAWSON, LL.D., F.R.S.

WHEN in London, last spring, Prof. Huxley was kind enough to show me some remarkably beautiful slices of coal mounted by his assistant, Mr. Newton, and showing with great distinctness multitudes of spore-cases and spores, some of them very well preserved. He farther stated to me his belief that such material had been largely or mainly instrumental in the production of Coal. At the time I declined to accept this conclusion, on the ground that the specimens probably represented layers of coal exceptionally rich in spore-cases; and that even in these specimens a large quantity of matter was present which long experience in the examination of coals enabled me to recognize as cortical or epidermal matter, which I had previously shown by my examination of the coals of Nova Scotia to be the principal ingredient in ordinary coal. I promised, however, on my return to Canada, to look over my series of preparations of coal, with a view to the occurrence of spore-cases, and also to make trial of the somewhat improved method of preparation employed by Mr. Newton. On my return I gave the results of my examination to Prof. Huxley, in a letter which he has quoted in the brilliant exposition of his observations and conclusions in the Contemporary review for November,* and which will probably give a tone to the representations of popular writers on this subject for some time. While, however, admitting the great interest and importance of Prof. Huxley's observations, and prepared to contribute some additional illustrations of the occurrence of spore-cases in coal, I think it well to direct attention anew to the actual composition of the substance, as proved by its mode of occurrence, and illustrated by my own extensive series of observations on the coals of Nova Scotia and Cape Breton, including the series of eighty-one seams exposed at the South Joggins, the whole of which I have examined *in situ* and under the microscope.

The occurrence of bodies supposed to be spore-cases in coal, is, as Prof. Huxley states, no new discovery; but in reality these may be said to be the first organisms recognized by any microscopic observer of coal—that is, if all the clear spots and annular bodies seen in slices of coal are really spore-cases. They were noticed by Morris as early as 1836, and they had been observed and described long before by Fleming in Scotland. Goeppert mentioned and figured them in his "Treatise on Coal" in 1848. Balfour described them in 1859 as occurring in Scottish coals, and Quekett figured them in his account of the

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* In the quotation the word "cubical" has been substituted for "cortical."

Torbane Hill mineral in the same year. In 1855 the latter microscopist showed me in London slices exhibiting round bodies of this kind, very similar to those now described by Huxley; but at that time I regarded them as concretionary, though Prof Quekett was disposed to consider them organic. Mr. Carruthers has summed up most of these facts in his account of his genus Flemingites in the Geological Magazine for October, 1865. The subject has also attracted the attention of microscopists in connection with the Tasmanite, or "white coal" of Tasmania, which is composed in great part of the spore cases of ferns.

I suppose that the oldest spore-cases known are those described by Hooker from the Ludlow formation of the Upper Silurian; but these, if really spore-cases, are different in structure from those ordinarily found in the coal-formation, more especially in the great thickness of their walls, and I am not aware that they have anywhere been found in considerable quantities.

The oldest bed of spore-cases known to me, is that at Kettle Point, Lake Huron. It is a bed of brown bituminous shale, burning with much flame, and under a lens is seen to be studded with flattened disc-like bodies scarcely more than a hundredth of an inch in diameter, which under the microscope are found to be spore-cases, slightly papillate externally, and with a point of attachment on one side and a slit more or less elongated and gaping on the other, figs. 1, 2, 3. I have proposed for these bodies the name *Sporangites Huronensis.* When slices of the rock are made, its substance is seen to be filled with these bodies, which, viewed as transparent objects, appear yellow like amber, and show little structure, except that the walls can, in some cases, be distinguished from the internal cavity, and the latter may be seen to inclose patches of flocculent or granular matter. In the shale containing them there are also vast numbers of rounded translucent granules which may be the escaped spores.

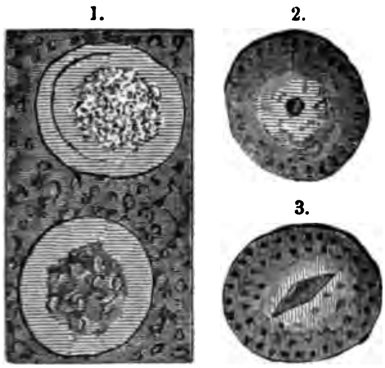

**Fig. 1, Part of a slice of shale from Kettle Point, showing two spore-cases and remains of spores. 70 diameters. Figs. 2 and 3, Spore-cases from the same, as opaque objects. 70 diameters.**

The bed at Kettle Point is stated in the report of the Geological Survey to be 12 to 14 feet in thickness; but to what degree either in its thickness or horizontal extent it retains the characters above described, I do not know. It belongs to the Upper Devonian, being supposed to be a representative of the Genesee slates of New York. It contains stems of *Calamites inornatus* and of a *Lepidodendron*, obscurely preserved, but apparently of the type of *L. Veltheimianum*, and possibly the same with *L. primævum* of Rogers. The spore-cases are not improbably those of this plant, or of the species *L. Gaspianum*, which belongs to the same horizon, though not found at this locality. The occurrence of this bed is a remarkable evidence of the abundance of Lycopodiaceous trees, whose spores must have drifted in immense quantities in the winds, to form such a bed. It is to be observed, however, that this is not a bed of coal, but a bituminous shale of brown color, and with pale streak, no doubt accumulated in water, and even marine, since it contains *Spirophyton** and shells of *Lingula*. In this it agrees with the Australian Tasmanite, which, though composed in great part of spore-cases of Ferns, is, as I am informed by Mr. Selwyn, an aqueous deposit, containing marine shells.

There is, however, one bed of true coal known in the Devonian of Eastern America, that of Tar Point, Gaspé, and it is curious to observe that this is not composed of spore-cases, but of successive thin layers of rhizomata and stems of *Psilophyton*, with occasional fragments of *Lepidodendron* and *Cyclostigma*. Rounded disks, which may be spore-cases, occur in it, but very rarely. In the bituminous shales associated with this coal, the microscope shows amber-colored flakes of irregular form, but these are easily ascertained to be portions of the epidermis of Psilophyton, or of the chitinous crusts of crustaceans which abound in these beds.

Ascending to the Lower Carboniferous (sub-carboniferous), there are great quantities of rounded spore-cases of the size of mustard seeds (*Sporangites glabra* of my papers) in the rocks of Horton Bluff and Lower Horton, Nova Scotia. They are sometimes globular, and filled with pyrite of a granular texture which perhaps represents the original cellular structure or the microspores. In other cases they are flattened and constitute thin carbonaceous layers. They are almost without doubt the spore-cases of *Lepidodendron corrugatum*, which abounds in the same beds, and constitutes in one place a forest of erect stumps. I described them in a paper on the Lower Carboniferous of Nova Scotia in the Proceedings of the Geological Society of London for 1858, though not then aware of their true nature, which was, however, recognized by Dr. Hooker in some specimens which I had sent to London.

In my paper on the conditions of accumulation of Coal, (Proceedings of Geological Society of London, May, 1866), I proposed the name *Sporangites* for these bodies, in consequence of the difficulty of referring them certainly to any generic forms. Carruthers had in Oct. 1865, described a cone containing rounded spore-cases of not dissimilar type, under the name *Flemingites.* In the paper above referred to, I stated that out of eighty-one coals of the South Joggins Section examined by me, I recognized these bodies and other fruits or Sporangia, in only sixteen; and of these only four had the rounded Lycopodiaceous spore-cases similar to those of Flemingites. These are the following:—

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* The well known *Cauda-galli* fucoid.

(1.) Coal group 12, of Division IV, has a bed of coal one foot thick, of which some layers are almost wholly composed of *Sporangites papillata.*

(2.) Coal group 13, Div. IV, has in some layers great quantities of *Sporangites glabra*, especially in the shaly part of the coal.

(3.) In Coal group 14, Div. IV, a shaly parting contains great numbers of similar Sporangites.

(4.) In Coal group 15*a*, Div. IV, the shaly roof abounds in sporangites, but I did not observe them in the coal itself.

In addition to these cases, all of which curiously enough occur in one part of the section, and among the smaller coals, I have noted the occurrence of clear amber spots in several of the compact coals, but I did not regard these as certainly organic, suspecting them to be rather concretionary or segregative structures.

The great coal beds of Pictou are, in so far as my observation has extended, remarkably free from indications of spore-cases, and consist principally of cortical and ligneous tissues with layers of finely comminuted vegetable matter. A layer of cannel, however, from a bed near New Glasgow has numerous flattened amber-colored discs, which may be of this character. In those of Cape Breton, the yellow spore-case-like spots are much more abundant; but these coals I have less extensively examined than those of the mainland of Nova Scotia. Of American coals, the richest in spore-cases, that I have seen, is a specimen from Ohio, which contains many large spore-cases, and vast numbers of more minute globular bodies apparently macrospores. It quite equals in this respect some of the English coals referred to by Huxley, (fig. 4). I have also a specimen of anthracite from Pennsylvania, full of spore-cases, some of them retaining their round form and filled with granular matter which may represent the spores.

4.

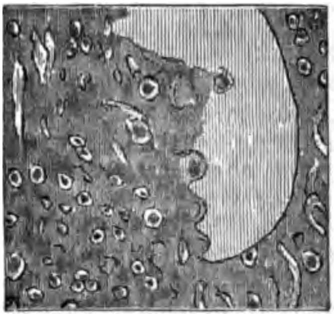

Fig. 4. Part of a slice of Ohio coal, showing at one side a part of a large spore-case, and numerous spores. 70 diameters.

It is not improbable that sporangites or bodies resembling them, may be found in most coals; but the facts above stated indicate that their occurrence is accidental rather than essential to coal accumulation, and that they are more likely to have been abundant in shales and cannel coals, deposited in ponds or in shallow waters in the vicinity of Lycopodiaceous forests, than in the swampy or peaty deposits which constitute the ordinary coals. It is to be observed, however, that the conspicuous appearance which these bodies and also the strips and fragments of epidermal tissue, which resemble them in texture, present in slices of coal, may incline an observer, not having large experience in the examination of coals, to overrate their importance, and this I think has been done by most microscopists, especially those who have confined their attention to slices prepared by the lapidary. One must also bear in mind the danger arising from mistaking concretionary accumulations of bituminous matter for sporangia. In sections of the bituminous shales accompanying the Devonian coal above mentioned, there are many rounded yellow spots, which on examination prove to be the spaces in the epidermis of Psilophyton through which the vessels passing to the leaves were emitted. To these considerations I would add the following, condensed from my paper above referred to, in which the whole question of the origin of coal is fully discussed.*

(1.) The mineral charcoal or "mother coal" is obviously woody tissue and fibers of bark; the structure of the varieties of which and the plants to which it probably belongs, I have discussed in the paper above mentioned.

(2.) The coarser layers of coal show under the microscope a confused mass of fragments of vegetable matter belonging to various descriptions of plants, and including, but not usually largely, sporangites.

(3.) The more brilliant layers of the coal are seen, when separated by thin laminæ of clay, to have on their surfaces the markings of Sigillariæ and other trees, of which they evidently represent flattened specimens, or rather the bark of such specimens. Under the microscope, when their structures are preserved, these layers show cortical tissues more abundantly than any others.

(4.) Some thin layers of coal consist mainly of flattened layers of leaves of *Cordaites* or *Pychnophyllum.*

(5.) The Stigmaria underclays and the stumps of Sigillaria in the coal roofs equally testify to the accumulation of coal by the growth of successive forests, more especially of Sigillariæ. There is on the other hand no necessary connection of sporangite beds with Stigmarian soils. Such beds are more likely to be accumulated in water, and consequently to constitute bituminous shales and cannels.

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* See also Acadian Geology, 2d edit., pp. 138, 461, 493.

(6.) Lepidodendron and its allies, to which the spore-cases in question appear to belong, are evidently much less important to coal accumulation than Sigillaria, which cannot be affirmed to have produced spore-cases similar to those in question, even though the observation of Goldenberg as to their fruit can be relied on; the accuracy of which, however, I am inclined to doubt.

On the whole then, while giving due credit to Prof. Huxley and those who have preceded him in this matter, for directing attention to this curious and no doubt important constituent of mineral fuel, and admitting that I may possibly have given too little attention to it, I must maintain that Sporangite beds are exceptional among coals, and that cortical and woody matters are the most abundant ingredients in all the ordinary kinds; and to this I cannot think that the coals of England constitute an exception.

It is to be observed, in conclusion, that the spore-cases of plants, in their indestructibility and richly carbonaceous character, only partake of qualities common to most suberous and epidermal matters, as I have explained in the publications already referred to. Such epidermal and cortical substances are extremely rich in carbon and hydrogen; in this resembling bituminous coal. They are also very little liable to decay, and they resist more than other vegetable matters aqueous infiltration; properties which have caused them to remain unchanged and to resist the penetration of mineral substances more than other vegetable tissues. These qualities are well seen in the bark of our American white birch. It is no wonder that materials of this kind should constitute considerable portions of such vegetable accumulations as the beds of coal, and that when present in large proportion they should afford richly bituminous beds. All this agrees with the fact, apparent on examination of the common coal, that the greater number of its purest layers consist of the flattened bark of Sigillariæ and similar trees, just as any single flattened trunk imbedded in shale becomes a layer of pure coal. It also agrees with the fact that other layers of coal, and also the cannels and earthy bitumens appear, under the microscope, to consist of finely comminuted particles, principally of epidermal tissues, not only from the fruits and spore-cases of plants, but also from their leaves and stems. The same considerations impress us, just as much as the abundance of spore-cases, with the immense amount of the vegetable matter which has perished during the accumulation of coal, in comparison with that which has been preserved.

I am indebted to Dr. T. Sterry Hunt, for the following very valuable information, which at once places in a clear and precise light the chemical relations of epidermal tissue and spores with coal. Dr. Hunt says—"The outer bark of the Cork tree and the cuticle of many if not all other plants consists of a highly carbonaceous matter, to which the name of ***suberin*** has been given. The spores of Lycopodium also approach to this substance in composition, as will be seen by the following, one of two analyses by Duconi,* along with which I give the theoretical composition of pure cellulose or woody fiber, according to Payen and Mitscherlich, and an analysis of the suberin of Cork, from *Quercus suber*, from which the ash and 2·5 per cent of cellulose have been deducted.†

| | Cellulose. | Cork. | Lycopodium. |
|---|---|---|---|
| Carbon, | 44·44 | 65·73 | 64·80 |
| Hydrogen, | 6·17 | 8·33 | 8·73 |
| Nitrogen, | —— | 1·50 | 6·18 |
| Oxygen, | 49·39 | 24·44 | 20·29 |
| | 100·00 | 100·00 | 100·00 |

This difference is not less striking when we reduce the above centesimal analyses to correspond with the formula of cellulose, $C_{24}H_{20}O_{20}$ and represent Cork and Lycopodium as containing 24 equivalents of carbon. For comparison I give the composition of specimens of Peat, Brown Coal, Lignite, and Bituminous Coal.‡

| | |
|---|---|
| Cellulose, | $C_{24}H_{20}\ O_{20}$ |
| Cork, | $C_{24}H_{18\frac{2}{10}}O_{6\frac{7}{10}}$ |
| Lycopodium, | $C_{24}H_{19\frac{4}{10}}NO_{5\frac{6}{10}}$ |
| Peat, (Vaux), | $C_{24}H_{14\frac{4}{10}}O_{10}$ |
| Brown Coal, (Schröther), | $C_{24}H_{14\frac{3}{10}}O_{10\frac{6}{10}}$ |
| Lignite, (Vaux), | $C_{24}H_{11\frac{3}{10}}O_{6\frac{4}{10}}$ |
| Bituminous Coal, (Regnault), | $C_{24}H_{10}\ O_{3\frac{3}{10}}$ |

It will be seen from this comparison that, in ultimate composition, Cork and Lycopodium are nearer to Lignite than to woody fiber; and may be converted into coal with far less loss of carbon and hydrogen than the latter. They in fact approach closer in composition to resins and fats than to wood, and moreover like those substances repel water, with which they are not easily moistened, and thus are able to resist those atmospheric influences which effect the decay of woody tissue."

I would add to this only one further consideration. The nitrogen present in the Lycopodium spores no doubt belongs to the protoplasm contained in them, a substance which would soon perish by decay; and subtracting this, the cell-walls of the spores and the walls of the spore-cases would be most suitable material for the production of bituminous coal. But this suitableness they share with the epidermal tissue of the scales of strobiles, and of the stems and leaves of Ferns and Lycopods; and above all with the thick corky envelope of the stems of Sigillariæ and similar trees, which as I have elsewhere shown,* from its condition in the prostrate and erect trunks contained in the beds associated with coal, must have been highly carbonaceous and extremely enduring and impermeable to water. In short, if instead of "spore-cases," we read "epidermal tissues in general, including spore-cases," all that Huxley has affirmed will be strictly and literally true, and in accordance with the chemical composition, microscopical characters and mode of occurrence of coal. It will also be in accordance with the following statement, which I may be pardoned for quoting from my paper on the Structures in Coal, published in 1859.

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* Liebig and Kopp, Jahresbuch, 1847–48.

† Gmelin, Handbook, xv, 145.

‡ Canadian Naturalist, vi, 253.

"A single trunk of Sigillaria in an erect forest, presents an epitome of a coal-seam. Its roots represent the Stigmaria underclay; its bark the compact coal; its woody axis, the mineral charcoal; its fallen leaves (and fruits), with remains of herbaceous plants growing in its shade, mixed with a little earthy matter, the layers of coarse coal. The condition of the durable outer bark of erect trees concurs with the chemical theory of coal, in showing the especial suitableness of this kind of tissue for the production of the purer compact coals. It is also probable that the comparative impermeability of the bark to mineral infiltration, is of importance in this respect, enabling this material to remain unaffected by causes which have filled those layers consisting of herbaceous materials and decayed wood, with pyrites and other mineral substances."

## ART. XXXVIII. — *On a method of fixing, photographing and exhibiting the Magnetic Spectra*; by ALFRED M. MAYER, Ph.D.

THE figures produced in iron-filings, when these are set in momentary vibration on a surface placed over a magnet, have received considerable attention from natural philosophers. The geometrical discussion of these spectra made by Lambert, Roget and others, have developed their symmetrical properties, and thereby have evolved the law of that action which emanates from the magnet. De Haldat has used them as a means of exploring the distribution and intensity of the effect of juxtaposed magnets variously arranged. But, above all, have the researches of Faraday and W. Thomson on "the magnetic field" and on "the lines of magnetic force" given to these spectra— even when merely regarded as conventional symbols— an importance which has been fully shown; especially by Faraday, who was guided by their consideration to some of his most important discoveries. They have thus risen to so high a theoretical importance that a method which will fix them without danger of distortion, photographically reproduce them and readily serve to exhibit them to the largest audiences, will, I imagine, be acceptable to both investigators and lecturers.

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* Vegetable structures in Coal, Journ. Geol. Soc., xv, 626. Conditions of Accumulation of Coal; ib. xxii, 95. Acadian Geology, 197, 464.

† See a neat "Démonstration par le calcul des courbes magnétiques de la loi de l'inverse du carré de la distance," by M. Cellerier, published as a note on p. 592, vol. i of De la Rive's Traité d'Électricité.

The only process of fixing these spectra, known to me, is that practiced by De Haldat and Faraday, which, however, is but an application to the magnetic spectra of the method previously invented by Savart for preserving the Chladni figures of vibrating plates. In this process the spectra, produced in the usual manner either on glass or card-board, have pressed upon them a sheet of paper coated with mucilage, to which the filings adhere. In this operation of the transfer many particles are deranged from their positions and the figures are yet more distorted by the shrinkage of the wet paper, and are therefore not fit to serve in measures of precision; while the impressions cannot be exhibited with much more facility than the originals.

My process is as follows: a clean plate of thin glass is coated with a firm film of shellac, by flowing over it a solution of this substance in alcohol,* in the same manner as a photographic plate is coated with collodion. After the plate has remained a day or two in a dry atmosphere, it is placed over the magnet, or magnets, with its ends resting on slips of wood, so that the under surface of the plate just touches the magnet. Fine iron-filings, produced by "draw-filing" Norway iron, which has been repeatedly annealed, are now sifted uniformly over the film of lac by means of a fine sieve. The spectrum is then produced on vibrating the plate, by letting fall vertically upon it, at different points, a light piece of copper wire. The plate is now cautiously lifted vertically off the magnet and placed on the end of a cylinder of pasteboard, which serves as a support in bringing it quite close to the under surface of a cast-iron plate (1 ft. diam. ½ in. thick), which has been heated over a large Bunsen-flame. Thus the shellac is uniformly heated and the iron-filings, absorbing the radiation, sink into the softened film and are "fixed."

I generally allow the heat to act until the metallic lustre of the filings has disappeared, by sinking into the shellac, and the film appears quite transparent. This degree of action is necessary when photographic prints are to be made from the plate, but when they are to be used as lantern slides I do not carry the heating so far. After the plate has cooled, it is allowed to fall upon its ends, on a table, so that any filings which have not adhered may be removed.

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* The shellac dissolved in strong alcohol is allowed to stand a week or more, and the clear supernatant solution is then decanted.

A short experience will give the proper strength of shellac solution to obtain a film so thick as *just to be sufficient to hold the filings*, and the requisite amount of heat to firmly cement them, without injuring the transparency of the film.

The plates can now serve (1) for the most accurate measures upon the magnetic-field; (2) for a photographic positive, which, in the printing-frame will produce the lines in white upon a dark ground, giving most beautiful and distinct impressions;* (3) or, if it is required to exhibit these figures to an audience, the plates are provided with glass covers, kept from touching the spectra by intervening slips of card-board, and there result "slides," in every way fit for giving a fine exhibition, when the images are projected upon a screen. I have thus obtained images, clear and sharp, of over 12 feet in diameter.†

By this process many plates have been produced; showing the action of single magnets of various forms, and of juxtaposed bars; as well as the effects of electric currents led by wires through holes drilled in the plates. Those exhibiting the inductive action of magnets on bars of soft iron and the interaction of magnets and electric currents are peculiarly interesting. An approximate representation of the resultant lines of the terrestrial magnetic action has been obtained by magnetizing *equably tempered* steel discs of from 2 ins. to 3 ins., and even more, in diameter. The magnetic axis or axes of these discs are *predetermined* by making them the continuations of the axes of very powerful electro-magnets, terminated with cones of soft iron with slightly rounded apices. The arcs of the great circles, including the terrestrial magnetic poles, having been calculated, the axes of the electro-magnets are inclined to that angle, while the steel disc is held close to their poles. On passing the current the disc is magnetized and we have an approximate representation of a section of the earth's magnetic effect. These results when viewed as photographic prints, or, as exhibited by the lantern, are so beautiful and instructive as to appear to me to warrant this somewhat formal description of the process of their production.

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* Photographic prints from a series of eight of these plates I have presented to Harvard College; American Academy of Sciences; Sheffield Scientific School; Columbia College; Stevens Institute of Technology, Hoboken; Lehigh University, Pa.; American Philosophical Society; Franklin Institute; Peabody Institute, Balt.; Smithsonian Institution; Chicago Academy of Sciences; and to the University of Virginia—where they can be examined by the readers of this paper.

† Several of these are 16 ins. long by 10 wide.

December, 1870.

Since sending the above to press I have subjected plates, coated with "sensitized" collodion to the action of the magnetic field. I had hopes of thus obtaining a *physical* impress on the plate which would appear on flowing the "developer." Sensitized films on glass and on iron plates were placed over and between the poles of an electro-magnet with cores 1·7 in. in diameter. Some plates were developed after removal from the magnet, others while under the magnetic action,—with and without the light having acted upon them—but no trace of effect has been detected.

I had also imagined that the magnet's action should have placed the affinities in a more unstable condition, so that the film would rise in sensitiveness after exposure in the magnetic field; but this, also, I could not detect; nevertheless, I have not given up the supposition that some action will be evolved when more appropriate films, far higher magnetic action and more delicate measures of actinic effect are used.

February 13, 1871.

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## ART. XXXIX.—*Notice of a Fossil Forest in the Tertiary of California;* by Professor O. C. MARSH, of Yale College.

DURING the visit of the Yale College Scientific party to the Pacific Coast, in October last, several members of the expedition, including the writer, while on their way from San Francisco to the "Geysers," took occasion to examine a locality, a few miles from the route, where a number of fossil trunks of trees had recently been discovered. This point proved to be of much scientific interest, and, since it has received as yet apparently little or no attention from geologists, it may be well to note the more important results of our investigation.

The locality is situated on a high rocky ridge, in Napa county, California, about five miles southwest of Calistoga Hot Springs, and perhaps ten miles south of the summit of Mount St. Helena. The existence at this place of several petrified trunks of trees was first made public by Charles H. Denison, Esq., of San Francisco, who visited the spot in July last, and, soon after, gave a short account of the discovery in the San Francisco Bulletin. Our party was especially indebted to Mr. Denison for information on the subject, and for accompanying us to the locality during our first visit. The ridge on which the fossil trees were found belongs to the Coast Range series, and forms the divide between the Napa and Santa Rosa valleys

It is about 2000 feet in height, and is mainly composed of metamorphic rocks of Cretaceous age,* which are in places, as we ascertained, overlaid, unconformably, by later Tertiary strata, consisting of light-colored, coarse sandstones, and beds of stratified volcanic ashes. This ridge had long been covered with a dense growth of "chaparral," but just before our visit a destructive fire had swept over a portion of it, rendering it comparatively easy to examine a large tract of country which apparently had never been explored.

A careful examination of the locality where the first prostrate trunks had been discovered soon made it evident that those now on the surface had all been weathered out of the volcanic tufa and sandstones, which form the summit of this part of the mountain ridge. Several large silicified trees were, indeed, subsequently found in the vicinity, projecting from the side of a steep bluff, which had partially escaped denudation. Extending our explorations among the mountains for several miles around, we were rewarded by the discovery of many additional fossil trunks at various points, showing conclusively that this Tertiary deposit contained the remains of an extensive forest of very large trees, which had apparently been overthrown and entombed by some volcanic irruption. Portions of nearly one hundred distinct trees, scattered over a tract three or four miles in extent, were found by our party, and the information we received from hunters and others, familiar with the surrounding country, renders it more than probable that the same beds, containing similar masses of silicified wood, extend over a much greater area.

The fossil trees washing out of this volcanic tufa were mostly of great size, and appeared to be closely related to some of the modern forest trees of the Pacific coast, especially the gigantic Conifers. One of the prostrate trunks examined during our explorations was only partially exposed above the surface, dipping with the strata about 10° to the northward. Its accessible portion, evidently but a small part of the original tree, measured sixty-three feet in length, and, although denuded of its bark and very much weathered, was over seven feet in diameter near its smaller end. On a high summit about a quarter of a mile west of this point, two other large trunks were found, one about five feet in diameter, lying east and west, with thirty feet of its length above the surface. The other rested directly on this, dipping with the strata to the north. The exposed fragments of this trunk indicated that the tree when standing could not have been less than twelve feet in diameter. These two trees had apparently fallen not far from where they were imbedded, as the bark was well preserved, both on the main trunks and on the small branches, numerous fragments of which were lying near. Many other trees were found, nearly or quite equal to these in size; and all those examined indicated a very large general growth for the original forest.

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* Geology of California, vol. i, p. 85.

All the trees discovered were prostrate, and most of them, after their petrifaction, had been broken transversely into several sections, apparently by the disturbance of the enclosing strata. A majority of the trunks had a general north and south direction, probably due to the course of the current that covered them with volcanic material, or perhaps indicating in some cases the position in which they had fallen. Several of the trunks had portions of their roots still attached, and some were evidently much decayed internally and worm eaten before their entombment. All the fossil wood observed was silicified, probably by means of hot alkaline waters containing silica in solution, a natural result of volcanic action, especially when occurring in connection with water, as was evidently the case in the present instance.

The trees closely examined appeared to be all conifers, and in their external characters, especially in the bark, mode of branching, and general habit of growth, most nearly resemble the modern redwoods, still flourishing in the same region. Dr. M. C. White, of New Haven, an authority in such matters, has, moreover, kindly made a microscopical examination of some of the best preserved specimens collected at this locality by the writer, and finds no essential difference between the structure of the fossil wood, and that of existing conifers of the genus *Sequoia*, to which the redwoods belong.

The beds enclosing the silicified wood appear to contain no other fossils, excepting here and there small fragments of charcoal, and hence their exact age is somewhat doubtful. As they rest unconformably on distorted and metamorphic Cretaceous strata, they are apparently as recent as Tertiary, and will probably prove to be Pliocene. The origin of the volcanic material which covered the forest cannot, perhaps, be definitely ascertained, without a careful examination of the surrounding region. It is not improbable, however, that it came from Mount St. Helena, the nearest volcanic peak, across the now intervening depression. Our party discovered on the western side of the Napa valley, along the base of the ridge, patches of a deposit of stratified tufa and gravel, which was evidently indentical with that containing the fossil trees on the summit. This would seem to imply that the upper portion of the valley had once been filled with these peculiar beds, and, through their denudation, had gradually attained its present proportions. However that may be, the volcanic deposit and its contents is certainly of great interest, even in this land of geological wonders, and is well worthy of a more systematic exploration than we were able to give it in the limited time at our command.

*Yale College, New Haven, February 10th, 1871.*

## ART. XL.—*On the Determination of the Alkalies in Silicates by ignition with Carbonate of Lime and Sal-ammoniac;* by J. LAWRENCE SMITH, of Louisville, Ky.

IN the following description of a method of separating and determining the alkalies, I aim to give the minutest details. Numerous analyses have given me the experience here presented; and I am convinced that analytical chemists, if they follow out the directions, will not resort to any other known method. If there be a better method it is yet to be discovered. The presence of boracic, hydrofluoric and phosphoric acids in the minerals in no way interferes with the process. Even in silicates *soluble in acids*, I prefer this method, in common with other analysts, for its ease and accuracy. I made the researches during the latter part of 1852, and the details were published early in 1853.* Since then I have employed the process many hundreds of times, with the most accurate results. Some minor points were not completed satisfactorily until several years after the first notice of the method; these have since been perfected, and I now know of nothing further that is needed.

The purpose of this article is to give all the improvements, with a minute detail of the manipulations, and of the precautions necessary, all of which are simple and easily executed. In the two articles on the subject of alkali determination in minerals published in 1853, the whole subject was reviewed, and it is needless to return to it now. I then considered the processes by caustic baryta and its salts, and by hydrofluoric acid, and also detailed some experiments on the separation of the different alkalies from each other, and on the microscopic examination of the same, etc. It was proved that, after the caustic alkalies, the most powerful agent to attack silicates at a high temperature is caustic lime, a fact not new to chemists. But for the purpose of arriving conveniently by this method at *a quantitative determination of the alkalies in silicates*, certain methods of manipulation, and facts with regard to quantity of material, admixture, etc. had to be discovered; and in them resides the success of my process—converting the most difficult parts of the analysis of a silicate into the easiest.

The methods of analysis by caustic baryta and by means of its carbonate, are now no longer used, for various reasons fully detailed by Rose in his Analytical Chemistry. The method still extensively employed is that with hydrofluoric acid, proposed by Berzelius; and when used with the necessary precautions, it has seemed to decompose all silicates; still, according to Rose, there are siliceous compounds that cannot be completely decomposed by hydrofluoric acid.*

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* Shortly after my first publication in this country, M. St. Claire Deville made known his method of analyzing the silicates by fusion with carbonate of lime, but the nature of his process and the objects to be arrived at were quite different from those attained in this process.

Dismissing all criticism, I at once proceed to the method which is the subject of this article, viz: the *Decomposition of Silicates by ignition with Carbonate of Lime and Sal-ammoniac.* A mixture of carbonate of lime and sal-ammoniac is used in the decomposition simply for the purpose of bringing the caustic lime to act, in a most thorough manner, upon the silicates at red heat.†

*Pure carbonate of lime.*—The first requisite is pure carbonate of lime. This is made in my laboratory, as follows: Take as good marble (calcite) as can be conveniently found, and dissolve it in hydrochloric acid (it is not necessary that the acid be perfectly pure), add an excess of the marble and warm the solution; to it add lime water or some milk of lime made from pure lime, until the solution is alkaline to test-paper; the lime is added to precipitate any magnesia, phosphate of lime, &c., that may have existed in the marble. Filter this solution and precipitate with carbonate of ammonia, after heating to at least 160° F.‡ The carbonate of lime thus precipitated is to be thrown on a filter and well washed with distilled water. Thus prepared, the carbonate of lime is a dense powder and perfectly pure, or if it contain any impurity, it will be a trace of carbonate of baryta or strontia, which in no way interferes with its use.

*Sal-ammoniac.*—To obtain this reagent in the most convenient form, take some fragments of clean sublimed sal-ammoniac, dissolve them in water with a gentle heat, filter, evaporate the filtrate over a steam bath or a sand bath, or by means of any other convenient gentle heat, and as the crystals deposit themselves, stir the solution to keep them small; when half or two-thirds of the sal-ammoniac is deposited, pour off the liquid without waiting for it to cool, throw on a cotton filter, and dry the crystals at the temperature of the atmosphere. In this way, sal-ammoniac is obtained that can be easily pulverized.

*Vessel for the decomposition.*—The ordinary platinum crucible can be used for this purpose, and for many years was employed by me. It was found, however, that while it is the best, hitherto contrived, both for precision and ease, there was yet a very minute quantity of alkalies lost by volatilization; and I made further researches to overcome this small loss. This I have successfully accomplished, and for some time I have used an improved form of crucible. The one for half to one gram of silicate, is of the following form and dimensions, viz: an elongated, slightly conical crucible with rounded bottom and cover (either with or without the central wire by which to hold it); length 95 mm.; diameter of opening 22 mm.; diameter of smaller end just at the turn of the bottom 16 mm.; weight about 35 to 40 grams. These are now made by Messrs. Johnson, Mattley & Co., Hatton Garden, London, to whom I have furnished all the necessary directions. This shape is given it in order that the portion of the crucible containing the mixture may be heated strongly, while the upper portion is below a red heat.

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* The process used by Deville, in fusing with carbonate of lime, is in most cases better than that by hydrofluoric acid, and one that I should use in preference to all others except the one now under notice.

† Chloride of calcium at a red heat will dissolve more or less caustic lime.

‡ This precaution must not be overlooked, as it is desirable to obtain the precipitated carbonate of lime as dense as possible. If the carbonate of ammonia be added to the cold solution, the precipitate, at first gelatinous, will ultimately become much more dense and settle readily; the same is true if the mixture be heated after the addition of the carbonate; but in neither case will it be as dense as when the carbonate is added to the hot solution of chlorid of calcium. The reaction in the analysis is in no way affected by the form of the carbonate of lime; but by using the denser form, the mixture occupies less space in the crucible.

*Manner of heating the crucible.*—The ordinary crucible, if used, may be heated in the manner commonly employed for the fusion of silicates. If the new form of crucible, however, is employed, then the upper part is grasped by a convenient metallic clamp in a slightly inclined position, and a moderate blast from the table blow-pipe made to play upon it for about 25 or 30 minutes. But as gas is to be found in every well-mounted laboratory, Bunsen burners of all dimensions are used, and when properly applied, can be made to give all gradations of heat; a simple, cheap, and convenient furnace, with a properly arranged draught, can be made to accomplish all fusions of silicates without the aid of any manual labor, and I therefore employ such an apparatus. (A description of it is given at the close of this article.)

*Method of analysis.*—We have now the pure carbonate of lime, granular sal-ammoniac and the proper crucible. The silicate should be well pulverized in an agate mortar;* and half a gram or one gram of it is taken. The former amount is most commonly used, it being sufficient and best manipulated in the crucible; a gram, however, may be conveniently employed. The weighed mineral is placed in a large agate mortar, or better in a glazed porcelain mortar, of half to one pint capacity; an equal quantity of the granular sal-ammoniac is weighed out (a centigram, more or less, is of no consequence), and put into the mortar with the mineral, and the two are rubbed together intimately. After this, add eight parts of the carbonate of lime in three or four portions, and mix intimately after each addition; empty the contents of the mortar completely upon a piece of glazed paper, that ought always to be under the mortar, and introduce into the crucible. The crucible is now tapped gently upon the table and the contents settled down.

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* While in all mineral analysis thorough pulverization of the mineral is usually essential, still it is a singular fact, very good analyses can be made with this method even when the powder is tolerably coarse, and in some experiments with lepidolite, I used powder of which much of it was in particles of from 1-40 to 1-30 of an inch, and obtained excellent results. Notwithstanding this, thorough trituration of the mineral is recommended.

The crucible is then clasped by a metallic clamp in an inclined position, or it is placed in the upper part of the support referred to in the latter part of this article, leaving outside about three-fourths of an inch or one inch. By means of a small Bunsen burner the heat is brought to bear just above the top of the mixture and gradually carried toward the lower part, until the sal-ammoniac is completely decomposed, which takes about five minutes; heat is then applied in the manner suggested, either with the blast, or with the burner referred to, acting by its own draught, and the whole kept up to bright red heat, for from 40 to 60 minutes. It is well to avoid too intense a heat.

The crucible is now allowed to cool, when the contents will be found to be more or less agglomerated in the form of a semi-fused mass. A glass rod or blunt steel point will most commonly detach the mass, which is then dropped into a platinum or porcelain capsule of about 150 centimeters capacity and 60 or 80 centimeters, and distilled water added. After some time, the mass will slack and crumble in the manner of lime; still better, this may be hastened by bringing the contents of the capsule to the boiling point, either over a lamp or water-bath; at the same time, water is put into the crucible to slack out any small particles that may adhere to it, and subsequently this is added to that in the capsule, *washing off the cover of the crucible also.*

After the mass is completely slacked, the analysis may be proceeded with: as a general thing, I prefer to allow the digestion to continue six or eight hours, though this is not necessary.

If the contents of the crucible are not easily detached, do not use very much force as the crucible may be injured by it, but fill the crucible to about two-thirds its capacity with water, bring it almost to the boiling point, and lay it in the capsule with the upper portion resting on the edge, the lime will slack in the crucible, and then may be washed thoroughly into the dish; also, as before, the cover is to be washed off.

We have now by this treatment with water, the excess of lime slacked into a hydrate, and some of the lime combined with the silica and other ingredients of the silicate in an impalpable form. In solution, there is an excess of chloride of calcium formed in the operation, and all the alkalies originally contained in the mineral, as chlorides. All that now remains to be done is to filter and separate the lime as carbonate and nothing is left but the chlorides of the alkalies. To do this, proceed as follows: Throw the contents of the capsule on a filter, the best size of which for the quantity above specified, is one 3 to 3½ inches in diameter; wash well, to do which requires about 200 centimeters of water; the washing is executed rapidly. The contents of the filter (except in those cases where the amount of the mineral is very small and there is no more for the estimation of the other constituents) is of no use, unless it be desired to heat again to see if any alkali still remains in it.

The filtrate contains in solution all the alkalies of the mineral, together with some chloride of calcium and caustic lime; to this solution, after it has been thrown into a platinum or porcelain capsule, is added a solution of pure carbonate of ammonia (an amount equal to about one and a half grams is required). This precipitates all the lime as carbonate; it is not, however, filtered immediately, but is evaporated over a water-bath to about 40 centimeters, and to this is added again a little carbonate of ammonia, and a few drops of caustic ammonia, to precipitate the little lime that is redissolved by the action of the sal-ammoniac on the carbonate of lime; filter on a small filter (2 in.) which is readily and thoroughly washed with but little water, and the filtrate allowed to run into a small beaker. In this filtrate are all the alkalies as chlorides, and a little sal-ammoniac. Add a drop of carbonate of ammonia, to make sure that no lime is present. Evaporate over a water-bath in a tared platinum dish, in which the alkalies are to be weighed; the capsule used is about 60 centimeters capacity, and during the evaporation is never filled to more than two-thirds its capacity.

After the filtrate has been evaporated to dryness, the bottom of the dish is dried, and on a proper support heated very gently by a Bunsen flame, to drive off the little sal-ammoniac. It is well to cover the capsule with a piece of thin platinum to prevent any possible loss by the spirting of the salt; after the sal-ammoniac has been driven off by gradually increasing the heat, the temperature of the dish is brought up to a point a little below redness, the cover being off. (The cover can be cleaned from any sal-ammoniac that may have condensed upon it by heating it over the lamp.) The capsule is again covered, and when sufficiently cooled, and before becoming fully cold, is placed on the balance and weighed. This weight gives as chlorides, the amount of alkalies contained in the mineral.

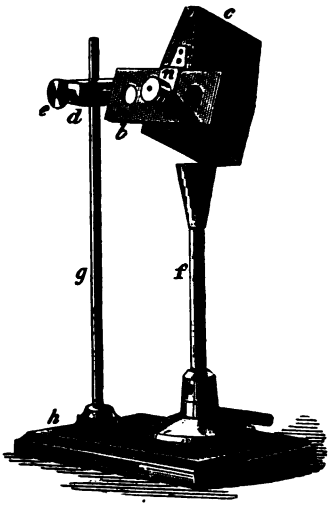
If the chloride of lithia be present, it is necessary to weigh rapidly, for this salt being very deliquescent takes moisture rapidly.

It not unfrequently happens that the chlorides at the end of the analysis are more or less colored with a small amount of carbon arising from certain constituents in carbonate of ammonia; the quantity is usually very minute and in no way affects the accuracy of the analysis. In selecting pure carbonate of ammonia for analytical purposes, it is well to take specimens that are not colored by the action of light.

It only remains now to separate the alkalies by the known methods. Under this head I have made several observations, that at some future time may be published as soon as the results are sufficiently definite.

*A special arrangement for heating the crucible by gas.*—The support and burner, where gas is to be had, are simple in their character and have been contrived after a great variety of experiments with gas furnaces. The figure here given illustrates the stand, burner, crucible, &c., and is about one-sixth the natural size.*

*h* is the stand with its rod *g*; *d* is a brass clamp with two holes at right angle to each other having two binding screws; it slides on the rod *g*; the second hole is for a round arm attached to *b*, the binding screw *e* fixing it in any position. *b* is a plate of cast iron five to six mm. thick, ten to eleven cm. long, and four and one half cm. broad, having a hole in its center large enough to admit the crucible to within about 15 mm. of the cover, without binding. *a* is the crucible already referred to which is made to incline a few degrees downward by turning the plate of iron that supports it. *c* is a chimney of sheet iron, eight to nine cm. long, ten cm. high, the width at the bottom being about 4 cm. at one end, and about three cm. at the other end. It is made with the sides straight for about four cm., then inclines toward the top so as to leave the width of the opening at the top about one cm. A piece is cut out of the front of the chimney of the width of the diameter of the hole in the iron support, and about four cm. in length, being semi-circular at the top, fitting over the platinum crucible. Just above this part of the chimney is riveted a piece of sheet iron in the form of a flattened hook *n* which holds the chimney in place by being slipped over the top of the crucible support; it serves as a protection to the crucible against the cooling of the currents of air.



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* This apparatus can be obtained from T. E. Jenkins & Co., of Louisville, Ky., importers and dealers in chemical apparatus.

*f* is the burner which has been described in an article on flame-heat in this Journal, II, vol. 1, p. 341. The upper opening of it is a slit from 1½ to 2 mm. in width, and from 3½ to 4½ cm. long, and when used is brought within about two cm. of the lowest point of the crucible, the end of the flame just playing around the lower end of the crucible; the gas enters the lower part of the burner by two small holes of one-sixteenth of an inch, furnishing at one inch pressure about 5½ cubic feet of gas per hour; the precaution must be observed already referred to, in heating the crucible at first gently above the mixture. It is surprising to see the effect produced by this simple burner as here used; 8 grams of precipitated carbonate of lime can be decomposed to within two or three per cent in one hour, and when mixed with silica or a silicate, in a very much shorter space of time; although in my analysis I employ one hour as it requires no attention after the operation is once started. This form of furnace and crucible is found to be convenient for other operations.

Although the details here given are long, the time occupied in the analysis is short, and the necessary precautions are of a simple character, so much so, that results obtained by students in beginning chemical analysis have been found by me far more reliable and less variable on the alkalies of the silicates than on any of the other constituents. Good alkali determinations can be made in three hours or less from the commencement of the operation, hastening the evaporation by more direct application of the heat, which of course requires more close watching

It is a common practice of mine, when a silicate presents itself of which there are no physical means of ascertaining its nature, to make at once an alkali determination, which not unfrequently indicates immediately what it is if it be a known silicate containing an alkali; and if an unknown compound, the analysis made is one step in the examination.

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## ART. XLI.—*On the Great Sun-spot of June,* 1843; by Professor DANIEL KIRKWOOD, Bloomington, Indiana.

ONE of the largest and most remarkable spots ever seen on the sun's disc appeared in June, 1843, and continued visible to the naked eye for 7 or 8 days. The diameter of this spot was, according to Schwabe, 74,000 miles; so that its area was many times greater than that of the earth's surface. Now, it has been observed during a number of sun-spot cycles that the larger spots are generally found at or near the epoch of the greatest numbers. The year 1843 was, however, a ***minimum*** epoch of the eleven-year cycle. It would seem, therefore, that the formation of this extraordinary spot was an anomaly, and that its origin ought not to be looked for in the *general cause* of the spots of Schwabe's cycle.

As having a possible bearing on the question under consideration let us refer to a phenomenon observed at the same moment, on the first of September, 1859, by Mr. Carrington, at Redhill, and Mr. Hodgson, at Highgate. "Mr. Carrington had directed his telescope to the sun, and was engaged in observing his spots, when suddenly two intensely luminous bodies burst into view, on its surface. They moved side by side through a space of about thirty-five thousand miles, first increasing in brightness, then fading away. In five minutes they had vanished. * * * It is a remarkable circumstance, that the observations at Kew show that on the very day, and at the very hour and minute of this unexpected and curious phenomenon, a moderate but marked magnetic disturbance took place; and a storm, or great disturbance of the magnetic element, occurred four hours after midnight, extending to the southern hemisphere."

The opinion has been expressed by more than one astronomer that this phenomenon was produced by the fall of meteoric matter upon the sun's surface. Now, the fact may be worthy of note that the comet of 1843, which had the least perihelion distance of any on record, actually grazed the solar atmosphere about three months before the appearance of the great sun-spot of the same year. The comet's least distance from the sun was about 65,000 miles. Had it approached but little nearer, the resistance of the atmosphere would probably have brought its entire mass to the solar surface. Even at its actual distance it must have produced considerable atmospheric disturbance. But the recent discovery that a number of comets are associated with meteoric matter, traveling in nearly the same orbits, suggests the inquiry whether an enormous meteorite following in the comet's train, and having a somewhat less perihelion distance, may not have been precipitated upon the sun, thus producing the great disturbance observed so shortly after the comet's perihelion passage.

## ART. XLII.—*Calorimetric Investigations;* by R. BUNSEN.*

(Continued from page 179.)

### *The Ice Calorimeter.*

IN order first to become better acquainted with the phenomena attending the formation of ice, although only in so far as they come under consideration in using the instrument, the calorimeter, containing a cylinder of ice and carefully surrounded with snow, was kept long under observation. It stood, as in all the following experiments, in a large earthenware decanting jar, through whose lower orifice the water dropping from the melted snow could continually flow off, so that a contact between the lower part of the instrument and the water thus formed was not to be feared. The instrument soon surrounds itself with a coherent mass of semisolid snow (firneis). If, after twelve or fifteen hours, a considerable cavity has been formed on the walls of the jar by the external melting of this mass, this cavity is then increased by smoothing off the loosely coherent substance with a spatula-shaped stick, the portions thus scraped off being stuffed into the vacent spaces under the calorimeter, and the snow lost by melting replaced with fresh. The first experiments were made with freshly fallen snow, which had been collected from a clean substratum of the same substance, and carefully shielded from every contamination arising from the soil. Of this snow, one hundred weight was preserved in a clean wooden chest, as a stock for the refillings during the experiments. With such a stock the calorimeter may by filling up twice daily, be kept for weeks in continual use without the necessity of renewing the ice-cylinder.

Throughout the entire duration of the observations, which occupied five days, the inner vessel enclosed in the ice-cylinder was kept closed with a rubber stopper, and the whole instrument, with the exception of the scale, surrounded on all sides with melting snow. The temperature of the room in which the observations were made varied between 0°·5 C. and 6°·C. The observations are presented in the following table 1. Column I, contains the time of the observations in hours. Column II gives the readings of the calorimeter scale for these times; the observed values are characterized by a star, the others have been calculated from these by interpolation. Up to the thirty-first hour the mercury which left the graduated tube was weighed; and the weight thus found transformed into scale-divisions according to equation (1). Column III has been calculated with the aid of equation (3), and gives the weight of the ice, expressed in grams, which has been formed in the instrument from the beginning of the period in question.

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* Translated for this Journal, with permission of the author, from Poggendorff's Annalen der Physik und Chemie, Bd. cxli, by Dr. G. E. MOORE, of San Francisco.

TABLE I.

| I. | II. | III. | I. | II. | III. | I. | II. | III. |
|---|---|---|---|---|---|---|---|---|
| 0 | 0·0 | 0·0 | 41 | 2739·8 | 2·3358 | 82 | 2810·5 | 2·3961 |
| 1 | 633·8 | 0·5404 | 42 | 2740·3 | 2·3363 | 83 | 2811·6 | 2·3971 |
| 2 | 1267·6 | 1·0807 | 43 | 2740·8 | 2·3367 | 84 | 2812·8 | 2·3981 |
| 3 | 1901·4 * | 1·6211 | 44 | 2741·3 | 2·3371 | 85 | 2813·9 | 2·3990 |
| 4 | 2033·1 | 1·7334 | 45 | 2741·8 * | 2·3376 | 86 | 2815·0 | 2·4000 |
| 5 | 2164·8 | 1·8456 | 46 | 2743·3 * | 2·3389 | 87 | 2816·1 | 2·4009 |
| 6 | 2296·5 | 1·9579 | 47 | 2744·7 | 2·3401 | 88 | 2817·2 | 2·4018 |
| 7 | 2428·2 * | 2·0702 | 48 | 2746·2 * | 2·3413 | 89 | 2818·4 | 2·4029 |
| 8 | 2443·4 | 2·0832 | 49 | 2747·0 | 2·3420 | 90 | 2819·5 | 2·4038 |
| 9 | 2458·6 | 2·0961 | 50 | 2747·8 | 2·3427 | 91 | 2820·6 * | 2·4048 |
| 10 | 2473·8 | 2·1091 | 51 | 2748·6 | 2·3434 | 92 | 2822·2 | 2·4061 |
| 11 | 2489·0 | 2·1220 | 52 | 2749·4 | 2·3441 | 93 | 2823·9 * | 2·4076 |
| 12 | 2504·2 * | 2·1350 | 53 | 2750·3 * | 2·3448 | 94 | 2825·1 | 2·4086 |
| 13 | 2528·6 | 2·1558 | 54 | 2751·6 * | 2·3460 | 95 | 2826·4 | 2·4097 |
| 14 | 2553·0 | 2·1766 | 55 | 2753·0 * | 2·3471 | 96 | 2827·6 * | 2·4107 |
| 15 | 2577·4 | 2·1974 | 56 | 2754·4 | 2·3483 | 97 | 2828·9 | 2·4118 |
| 16 | 2601·8 | 2·2182 | 57 | 2755·8 * | 2·3495 | 98 | 2830·2 | 2·4130 |
| 17 | 2626·2 | 2·2390 | 58 | 2758·0 | 2·3514 | 99 | 2831·6 | 2·4141 |
| 18 | 2650·6 | 2·2598 | 59 | 2760·2 | 2·3533 | 100 | 2832·9 * | 2·4152 |
| 19 | 2675·0 | 2·2806 | 60 | 2762·4 | 2·3551 | 101 | 2834·2 | 2·4164 |
| 20 | 2699·4 | 2·3014 | 61 | 2764·6 | 2·3570 | 102 | 2835·6 | 2·4176 |
| 21 | 2723·8 * | 2·3222 | 62 | 2766·9 | 2·3590 | 103 | 2836·9 * | 2·4186 |
| 22 | 2724·8 | 2·3231 | 63 | 2769·1 | 2·3608 | 104 | 2837·6 | 2·4193 |
| 23 | 2725·8 | 2·3239 | 64 | 2771·3 | 2·3627 | 105 | 2838·3 | 2·4199 |
| 24 | 2726·8 | 2·3248 | 65 | 2773·5 | 2·3591 | 106 | 2839·0 | 2·4204 |
| 25 | 2727·8 | 2·3256 | 66 | 2775·7 | 2·3665 | 107 | 2839·7 | 2·4211 |
| 26 | 2728·8 | 2·3265 | 67 | 2777·9 | 2·3684 | 108 | 2840·4 | 2·4217 |
| 27 | 2729·8 | 2·3273 | 68 | 2780·9 | 2·3709 | 109 | 2841·1 | 2·4223 |
| 28 | 2730·8 | 2·3282 | 69 | 2783·9 * | 2·3735 | 110 | 2841·8 | 2·4229 |
| 29 | 2731·8 | 2·3291 | 70 | 2786·2 | 2·3754 | 111 | 2842·5 | 2·4234 |
| 30 | 2732·8 | 2·3297 | 71 | 2788·5 * | 2·3774 | 112 | 2843·2 * | 2·4240 |
| 31 | 2733·8 | 2·3307 | 72 | 2790·7 | 2·3793 | 113 | 2843·9 | 2·4246 |
| 32 | 2734·8 | 2·3316 | 73 | 2792·9 | 2·3811 | 114 | 2844·6 * | 2·4252 |
| 33 | 2735·8 * | 2·3324 | 74 | 2795·0 | 2·3829 | 115 | 2844·6 | 2·4252 |
| 34 | 2736·3 | 2·3329 | 75 | 2797·1 | 2·3847 | 116 | 2844·6 * | 2·4252 |
| 35 | 2736·8 | 2·3333 | 76 | 2799·2 | 2·3865 | 117 | 2844·6 | 2·4252 |
| 36 | 2737·3 | 2·3337 | 77 | 2801·3 * | 2·3883 | 118 | 2844·6 * | 2·4252 |
| 37 | 2737·7 | 2·3342 | 78 | 2803·2 | 2·3899 | 119 | 2844·6 | 2·4252 |
| 38 | 2738·3 | 2·3346 | 79 | 2805·2 * | 2·3916 | 120 | 2844·6 * | 2·4252 |
| 39 | 2738·8 | 2·3350 | 80 | 2807·3 | 2·3934 | | | |
| 40 | 2739·3 | 2·3354 | 81 | 2809·4 * | 2·3952 | | | |

The table shows that about two grams of the water, contained in the calorimeter, froze at the temperature of melting snow during the first seven hours, that this freezing at the temperature of melting snow continued 114 hours in diminishing ratio, and that after this long time a period began, in which the water did not freeze further at the temperature of melting snow. The disproportionately great formation of ice at the beginning of the experiment arose evidently from the low temperature which the cylinder of ice, formed at –15° C. to –20° C., originally possessed, as the following consideration shows. Let it be assumed that the amount of ice $g$, formed during the first seven hours originated in the loss of heat which the water suffered in order to warm the ice-cylinder from $-t^\circ$ to 0° C., then will the mean temperature, which the ice-cylinder must have had in order to produce the above named weight of ice, result from the equation $t = -\frac{lq}{s_w G}$, wherein $l$ signifies the heat of melting for water, $s_w$ the specific heat of ice, and G the weight of the ice-cylinder cooled to $t^\circ$. In this equation only G is unknown. After the termination of the series of experiments in table 1, in order to determine G, the open end of the scale tube was dipped into a weighed glass vessel full of mercury, and, after the ice cylinder had melted and the instrument had been brought again to 0° C., the loss in weight $G_1$ of the mercury vessel was ascertained. The desired weight of the ice-cylinder is $G = \frac{G_1 p}{s_q v}$, wherein $s_q$ signifies the specific gravity of mercury as 0° C., $p$ the weight of melted ice corresponding to one division on the scale (equation 3), $v$ the volume of one scale division (equation 1). The values of the terms occurring in this and the preceding equation are:

$l = 80{\cdot}03$ $s_q = 13{\cdot}596$ $s_w = 0{\cdot}48$
$q = 2{\cdot}13$ grm. $G_1 = 61{\cdot}227$ grm. $p = 0{\cdot}0008526$ grm.
$v = 0{\cdot}00007733$ cubic centimeter.

By the substitution of these values in the equation there results, as the weight of the ice cylinder used in the observations $G = 49{\cdot}65$ grm.
and for its temperature $t = -6^\circ{\cdot}95$ C.

The ice cylinder, which had been produced at a temperature of at least −15° C., needed therefore to have possessed, at the time the instrument was placed in the snow, a temperatue −7° C. only, in order to have produced by its warming to 0° C. the formation of ice observed during the first seven hours. As from the determination of specific heat communicated beyond, it may be concluded that a period of seven hours is far more than sufficient to equalize a difference of temperature of 7° C. in the instrument, it is necessary to ascribe the ice formation which is visible in the table and which lasted more than 100 hours, to another cause than the one under consideration. Without entering further into the question whether this cause is to be sought for in the air contained in the snow water, as C. Schultz* assumes, or whether the passage of the snow to the semi-solid state (firneis), plays therein a part, it may suffice in the first place, to give prominence only to those influences determining a lowering of the melting point of ice, which are particularly deserving of attention in the employment of the ice-calorimeter. If the pure snow which surrounds the instrument be saturated with as much boiled-out or distilled water of 0° C., previously shaken with air, as it can retain after the excess has been allowed to drain off, there ensues, at least during the first twelve hours, during which alone the observations were carried on, no freezing but such a melting of the ice in the interior of the instrument that it would, under these circumstances, be entirely unserviceable for observation. On the other hand the slightest impurity of the snow determines such a large continual deposition of ice on the ice cylinder, that the mercury thread often advances in one minute several divisions on the scale. Snow which has absorbed even traces of salts from the soil, or of animal, or vegetable impurities from the street pavement, shows this lowering of the melting point in the most striking manner. River ice of such purity that the water obtained from it by melting, showed with barium chloride and silver solution only after a long time, a scarcely perceptible turbidness produced in the instrument during three days two grams of ice. After these observations it is self-apparent that only the purest snow can be used in the experiments. It is also advantageous to work in an apartment whose temperature is not too high above 0° C., and not to begin the observations, until the formation of ice on the ice-cylinder does not exceed a few scale divisions in the hour. Above all, however, care must be taken that, before the instrument is allowed to take, in the snow, a constant temperature, a small layer of water has been formed by melting between the glass walls and the adjacent ice-cylinder, in order that unequal tension and its consequent elastic after-effect may be avoided.

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* Pogg. Annalen, cxxxvii, 253.

The accuracy of the observations depends, however, most essentially upon the care which has been taken in the original arrangement of the instrument, that all the air absorbed by the mercury and water be removed. This is to be attained in the following manner: the instrument, filled to the half with boiled out water, is fastened with the mouth turned downward on the arm of a retort-holder, the mouth of the tube *c*, fig. 1, which is not yet provided with an iron casing, is sunk in water which is kept in constant ebullition in a beaker-glass, and the water in the instrument which reaches to $\beta$ kept boiling until it has evaporated to $\frac{1}{3}$. If now the lamp used to heat the apparatus be removed, the latter will fill itself with airless water. It is allowed to cool and is then, after it has been placed upright as in the drawing, filled to the height $\beta$ with so much freshly boiled-out mercury, that the mercury level in the vessel *b* stands about equally high with that in the tube *c*. The water s now for the most part removed with a pipette from the tube , the tube is freed from all moisture by means of a current of lry air produced by the water air-pump, and only then is the ron head-piece *d* cemented on with the finest sealing wax, in uch a manner, that the tube *c* projects inside to some distance bove the bottom, in order that later, the stopper bearing the cale may rest in the mouth of the glass tube *c* and not in the ron casing. The last filling with boiled mercury to the level *v* is performed by the aid of a capillary glass tube, in order o avoid all air bubbles on the sides of the tube.

In order to place the mercury thread in each experiment on ne of the first divisions of the scale, it suffices to press the ork of the graduated tube, with a rotary movement, somewhat leeper into the mercury tube *c*, fig. 1. If the thread has thereby exceeded the commencement of the scale, there is a small brass weight, fastened on a thread and previously warmed by ontact with the hand or tongue, sunk into the fluid *a*, fig. 1. If the weight of the brass weight be *g* grams, its temperature , its specific heat $s_m$, the latent heat of melting for water *l*, and the weight of melted ice, obtained by equation (2), which corresponds to an oscillation of one scale division, denoted by p, then the oscillation produced by the brass weight *g* is equal to $\frac{s_m t g}{l p}$ scale divisions. If we let

$$t=37° \text{ C.} \qquad s_m=0{\cdot}0939 \qquad l=80{\cdot}03 \qquad p=0{\cdot}000853$$

nd *g* equal successively 0·1, 0·2, 0·4, 0·6, ...... grams, the following retreats of the mercury thread, expressed in round numbers, will be obtained.

| | | | |
|---|---|---|---|
| 0·1 grm. | 5 scale divisions. | 0·6 grm. | 30 scale divisions. |
| 0·2 " | 10 " " | 0·8 " | 40 " " |
| 0·4 " | 20 " " | 1·0 " | 50 " " |

By dipping in one of these brass weights, previously warmed nder the tongue, the mercury thread can be made to retreat to he desired extent. The oscillations corresponding to the little veights, which were only warmed to 37° C., are well adapted o give an idea of the extraordinary delicacy of the instrument. The increase of temperature which 0·4 grams of brass at 37° C. would produce by immersion in the mass of water in the nstrument, amounting to about 20 grams would displace the nercury thread of a centigrade thermometer only 0°·07, that f the just described calorimeter, however, twenty scale divisions, each of which was, in the instrument employed, one nillimeter in length.

In relation to the readings on the scale, it is still to be observed hat, before such observation of the scale tube, which is best to be made with the telescope, the former must, particularly when t is very narrow, be gently agitated by repeated rapping until the capillary resistance is overcome, and the mercury thread does not retreat by further rapping.

Table 1 shows already that the mercury thread of the instrument is generally not perfectly stationary. The displacement, which, in a positive as in a negative sense may amount to 1 to 3 divisions in the hour, is, as the observer may easily perceive by the employment of the calorimeter, nearly proportional to the time. The slight error thus introduced may be eliminated in the following manner: As soon as it is seen that the instrument has become sufficiently stationary, the height of the mercury thread is noted from 30 to 30 minutes. If the displacement of the latter amounts in $m$ minutes to $r_0$ scale divisions, then the displacement to be ascribed to foreign influences is for one minute $\frac{r_0}{m_0}$.

The hour $M_0$ and the height of the mercury thread $Q_0$ are now observed at the moment, when the substance to be investigated is allowed to fall from the heating vessel *f*, fig. 4, (see page 173) into the calorimeter vessel *a*, fig. 1, and both observations are repeated one hour later, whereby further $M_1$ and $Q_1$ result; finally the movement of the mercury thread independent of the heat to be measured, is once more determined, as in the beginning of the experiment $\frac{r_1}{m_1}$.

The mean displacement of the mercury thread, independent of the experiment, amounts therefore in one minute to

$$\tfrac{1}{2}\left(\frac{r_0}{m_0}+\frac{r_1}{m_1}\right)$$

and throughout the entire duration of the experiment to

$$(M_1-M_0)\tfrac{1}{2}\left(\frac{r_0}{m_0}+\frac{r_1}{m_1}\right)$$

scale divisions. This value is to be added to the oscillation of the mercury thread $Q_0-Q_1$ observed during the experiment as a correction, and especially, with the negative sign prefixed when the displacement independent of the experiment took place in the way of ice melting, with the positive sign in the opposite case. For the oscillation T, corresponding to the quantity of heat to be measured, the equation

$$T=(Q_0-Q_1)+(M_1-M_0)\tfrac{1}{2}\left(\frac{r_0}{m_0}+\frac{r_1}{m_1}\right)$$

is therefore obtained, wherein it is hardly necessary to mention, that, for the direct readings, their values according to the table of calibrations are to be substituted.

(To be continued.)

## ART. XLIII.—*On the Solar Protuberances; Abstract of a Note read by* Prof. L. RESPIGHI, *before the Accademia de' Nuovi Lincei*, Dec. 4, 1870.* With a plate.

THIS note is founded upon spectroscopic observations of the border and protuberances of the sun regularly made by Prof. Respighi, at the Campidoglio observatory in Rome, from Oct., 1869, to Nov., 1870. The author deduces some important facts relative to the forms, size, development, and transformation of the protuberances; to their duration, and the manner of their distribution over the solar disk; and to their connection with the other solar phenomena, namely, the spots and the faculæ.

Among the surprisingly various and singular forms of the protuberances, he finds those that have the appearance of gaseous masses issuing from the sun's surface to be so marked and constant, that it is necessary to conclude that they are really produced by gaseous eruptions from within the body of the sun, taking place with more or less energy, and on a varying scale of grandeur.

Not being able to explain the various modes according to which the erupted masses are ramified and diffused, by referring them to the simple velocity of eruption combined with the action of gravitation, and with the natural expansion of the jets, or by the resistance of the solar atmosphere, or on the supposition of powerful currents in the latter, he finds it necessary to admit the concurrence of other forces acting within the erupted masses, and between these and the body of the sun.

In regard to the dimensions of the protuberances, spectroscopic observations show that they may vary between the most remote limits, from jets which are very small and low, to those of enormous section and of immense altitude. Among the protuberances sketched by Prof. Respighi, which exceed 4,000, there are more than 700 not less than 1′ high, that is, more than three times the diameter of the earth in altitude, and among these some not less than 6′, that is, more than 20 times the earth's diameter in height.

To these immense altitudes of the protuberances, correspond, very often, expansions or ramifications in a horizontal direction, which are truly astounding, and in which the hydrogen diffuses itself in vast volumes, or stretches out in branches more or less subtile and of enormous length.

Prof. Respighi observes that the loftiest protuberances observed by him show, besides the spectral line C, which is very distinct, also the line F, and the yellow line $D^3$,* to their very summits, a fact already remarked by him in a previous note.

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* Translated for this Journal, by Prof. ARTHUR W. WRIGHT, of Williams College, Williamstown, Mass., from Secchi's Bull. Met., Rome, Dec. 31, 1870.

The development of the protuberances is ordinarily announced by bright points or patches standing out upon the chromosphere (*strato rosato*), from which subsequently burst forth jets more or less subtile, which rise, sometimes slowly, sometimes rapidly, to considerable elevations, and then fall back in parabolic forms upon the sun, or diffuse themselves in masses of varying and sometimes very singular conformation, and subject to more or less rapid transformations. Prof. Respighi has been able now and then to be a witness of the development, in the neighborhood of the spots, of enormous protuberances, produced by the eruption of groups of very slender and brilliant jets, which in a short time spread into great cloudy masses, either settling down upon the surface of the sun, or gradually vanishing at a great height above it. An example of this kind of eruption is given in the plate, in the figure of the protuberance No. 14, observed October 29, 1870.

Respecting the duration of the spots, it is found that while some of them are developed in the space of a few minutes, and, after undergoing rapid transformations, in a few minutes thin out and disappear, others remain visible for a long time, sometimes retaining in their forms some characteristic traits. Those which are the most variable and evanescent, are produced in the neighborhood of the spots. Outside the zone of spots, up to about 70° in latitude, the protuberances commonly remain visible for many days, so that it is possible to follow by them the rotation of the sun; and it has been possible, in the course of the observations, to observe the passage of some of the protuberances from one border of the sun to the other, and also their return to the first border, after having made a complete revolution. The time of the sun's rotation as deduced by means of the protuberances agrees very closely with that obtained by observation of the spots near the equator; which shows that the retardation of this rotation observed in the spots distant from the equator, is an appearance due to the proper motion of the spots themselves.

In regard to the distribution of the protuberances upon the solar surface, Prof. Respighi finds the results deduced from the earlier observations confirmed, namely, that in the circumpolar regions, within a distance of 20° from the poles, the protuberances are either not found, or occur only exceptionally; though notwithstanding this, the surface of the sun in these regions cannot be in a condition of perfect calm; for the appearance of small jets, and the irregularity and variability of the chromosphere, show that even in those regions there is a state of continuous eruption, though on a very small scale.

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* This is doubtless the line observed by Mr. Lockyer, Oct. 20, 1868. In a communication to the Royal Society made that year, he says, speaking of the observation of a solar protuberance. "two of the lines correspond with Fraunhofer's C and F; another lies 8° or 9° (of Kirchhoff's scale) from D toward E. * * * It is remarked that the line near D has no corresponding line ordinarily visible in the solar spectrum. See also Mr. Lockyer's account of the recent eclipse (from *Nature*; this Journal, III, i, 229) where this line is attributed to a new element, a deduction first made we understand by Prof. Young. A. W. W.

Considering the whole body of observations made, it appears that the northern hemisphere is perceptibly more characterized by great protuberances and gigantic eruptions than the southern, and that in the former large protuberances are on rare occasions seen at distances less than 20° from the pole, a thing which never happens in the southern hemisphere. In the vicinity of the equator, protuberances of great size occur less frequently than in higher latitudes.

As to the connection of the protuberances with the faculæ, it is found that the latter are commonly accompanied by protuberances of considerable size, though without being confounded with them in the same phenomenon. Thus it would appear to be proved that the faculæ are special modifications of the photosphere in the neighborhood of powerful eruptions.

The following results have been deduced from a great number of observations made upon the border of the sun's disk, in the region of the spots :—

1. In the neighborhood of the spots the chromosphere (*strato rosato*) is rather low, quite regular and intensely bright.

2. Upon the exact locality of a spot, or rather over its nucleus, the chromosphere is generally very low and sometimes totally wanting.

3. At the nucleus, either there are no eruptions or they are confined to jets of great subtilty and little duration.

4. The nuclei of the spots are either totally obscure or possess very feeble luminosity.

5. Along the borders of the spots, jets are thrown up of extraordinary intensity and violence and of very definite configuration.

6. The jets adjoining the spots consist not solely of hydrogen, but also of other substances, as is shown by their respective bright lines in the spectrum.

7. Among these bright lines which are commonly found at the base or in the lower portions of the jets, there are frequently seen those of sodium, magnesium, iron, &c., and constantly two lines in the red, one between C and B, distant from C $\frac{41}{100}$ of the space C—B; the other is between B and *a*, distant from *a* $\frac{88}{100}$ of the space B—*a*. These lines do not correspond with those of any substance yet known. They are also not infrequently seen quite bright in the highest parts of the jets.

8. Now and then the eruptions in the vicinity of the spots assume gigantic proportions, and are probably the cause of the

rapid changes of form and position which are observed in the spots themselves.

9. There are often seen, in the neighborhood of the spots, jets curved backward upon the solar disk in forms which are sensibly parabolic.

10. The immense jets and erupted masses near the spots expand and vanish away more rapidly than in any other region.

11. On the area of the spots neither the photosphere nor the edge of the sun's disk shows any perceptible irregularity, that is, neither any perceptible prominence nor depression.*

From these results obtained by spectroscopic observations of the border of the sun and of the protuberances, Prof. Respighi is led to certain conclusions relative to the physical constitution of the sun, among which the following may be mentioned.

In the first place, the photosphere would appear to be the surface of an incandescent liquid mass or stratum, of suitable specific gravity, by the weight of which various gases, and especially hydrogen, are confined and compressed in the interior of the sun, at an elevated temperature, under an enormous tension, and with a density differing but little from that of the superincumbent liquid stratum.†

These gaseous masses in the interior of the sun, not yet having been brought to a condition of stable equilibrium, might in some portions be less condensed, and hence from hydrostatic pressure would rise toward the surface with great velocity, until, overcoming by their enormous expansive force the resistance of the liquid statum, they would burst through it with a velocity greater or less according to the depth from which they emerged, and the degree of tension in which they originally were, and would thus develop those jets or eruptions which constitute the protuberances.

The masses thus erupted, then, would not be determined in their movement solely by their initial velocity and the action of gravitation, but would generally be subjected to the operation of other forces which would concur in their elevation, their diffusion, and their ramification into those extraordinary forms which the protuberances present. According to this hypothesis, the hydrogen issuing from the body of the sun would serve as aliment to the chromosphere, repairing thus the rapid losses of the latter, by its not improbable combination with the substances of the photosphere ; and it does not appear to Prof. Respighi absurd to suppose that this immense stratum of incandescent hydrogen, that is, the chromosphere, may be the principal source of the heat radiated from the sun.

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* See foot note on next page.

† See the article of Prof. Zöllner, translated from the Proceedings of the Royal Saxon Society of Sciences, June 2, 1870, published Nov., 1870, in the Philosophical Magazine, where substantially these views are stated at length, and thoroughly discussed.

In regard to the spots, spectroscopic observations appear to show that they are neither cavities nor clouds, but are merely superficial modifications,* that is, partial obscurations of the photosphere, produced probably, by scoria or scum floating upon it. On the contrary, regard being had to the well defined forms of the jets neighboring the spots, to their extraordinary subtilty, and to their enormous energy, the supposition does not appear to the author irrational, that the nuclei of the spots consist of portions slightly projecting from the photosphere, of solid masses or islands floating upon the liquid stratum which envelops the body of the sun. The immense chains of jets or protuberances, which rise ordinarily in the region of the spots, might be the cause of those great transformations which are observed in the latter, and determine, by their resistance in the superficial strata, currents in a direction opposite to that of the solar rotation, from which would result the proper motion of the spots themselves. The limits of an article forbid entering into the arguments by which Prof. Respighi endeavors to justify these conclusions, hypotheses, in great part at least, already advanced by others, but without that impress of plausibility and probability which they gain from the results of the spectroscopic observations discussed in this note.

The note is accompanied by four plates. Three of these represent 140 profiles of the sun, and the fourth contains sketches of some of the more remarkable protuberances observed by the author, and is the one accompanying this article.

On the plate, which contains 23 figures, the protuberances of approximately similar forms are grouped together. The observations were all made in 1870, and severally at the following times:

No. 1, Aug. 12, $11^{h}$; 2, Feb. 26, $10^{h}$ $40^{m}$; 3, Jan. 4, $1^{h}$ $15^{m}$; 4, Oct. 7, $2^{h}$ $50^{m}$; 5, Sept. 5, $1^{h}$; 6, July 23, $10^{h}$; 7, Jan. 17, $3^{h}$ $45^{m}$; 8, Nov. 12, $10^{h}$ $20^{m}$; 9, Nov. 25, $9^{h}$ $45^{m}$; 10, Jan. 24, $12^{h}$ $40^{m}$; 11, Oct. 25, $10^{h}$ $40^{m}$; 12, Dec. 2, $1^{h}$; 13, Aug. 26, $6^{h}$ $15^{m}$; 14, Oct. 29, $12^{h}$ $30^{m}$; 15, Oct. 2, $9^{h}$ $45^{m}$; 16, Nov. 24, $3^{h}$ $48^{m}$; 17, March 11, $4^{h}$ $40^{m}$; 18, July 30, $9^{h}$ $16^{m}$; 19, Aug. 24, $12^{h}$; 20, July 1, $2^{h}$ $25^{m}$; 21, Oct. 28, $1^{h}$ $24^{m}$; 22, April 18, $10^{h}$ $7^{m}$; 23, Aug. 23, $10^{h}$.

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* This conclusion is entirely at variance with those of other observers, unless the author designedly omits the consideration of the penumbra, or makes no distinction between it and the umbra. The observations of Prof. Wilson in the last century, and of many others since, have shown that the nucleus or umbra is very often, if not generally, lower than the penumbra and the surrounding luminous masses. Some years since, Mr. De la Rue made a photograph of a solar spot, and another of the same spot after an interval of a day or two. When these were placed in a stereoscope the spot appeared funnel-shaped, the central portion being clearly lowest. Also Zöllner and Lockyer have found in the displacement of the lines in the spectroscope, that there is sometimes decided evidence of a downward motion, in the dark portion of a spot. In the remarkable article, previously referred to, published in the Phil. Mag., Nov., 1870, Prof. Zöllner says. "almost all observers agree in admitting that the umbra lies at a lower level than the surrounding parts. The depth at which the umbra lies has been ascertained partly by direct (De la Rue, Stewart, Loewy), partly by indirect (Faye) observations, to be about 8″." A. W. W.

## Art. XLIV.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XIII.—*Descriptions of new and imperfectly known Ascidians from New England*; by A. E. Verrill.

[Continued from page 212.]

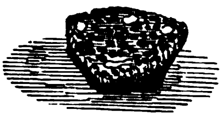
### Family, Polyclinidæ.

*Amouroucium glabrum* Verrill, sp. nov. Figures 20 to 22.

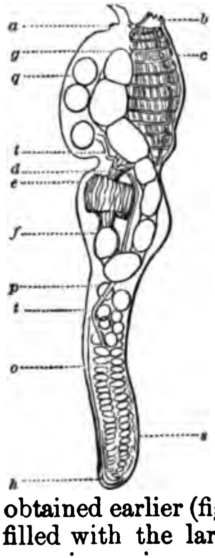
When young (fig. 20) this species forms small, clavate, or turbinate, translucent masses, attached by a narrow base, and containing only a few animals arranged somewhat irregularly around a single cloacal opening. The surface is smooth and glabrous, without adhering sand; the texture is rather firm, but so transparent as to distinctly show the animals, which are elongated and comparatively large, standing nearly vertically, with the ovaries extending nearly to the base of the mass. The intestines, filled with pellets of fœcal matter, appear as conspicuous, dark, oblique spots.

20.

21.



22.



Larger specimens (fig. 21) become ·5 to 1 inch or more broad and have a large attachment and expanding sides, with a more or less irregular, smooth upper surface, which is usually slightly convex. Several cloacal openings are irregularly placed on the upper surface, and numerous individuals are irregularly scattered throughout the mass, though often forming rather indistinct circular groups around the apertures. The surface is glabrous and the tissues translucent, as in the younger specimens.

The animals, when mature, are mostly about ·20 of an inch long, and about ·05 in diameter; but many are ·25 of an inch long and ·06 to ·07 in diameter. The thorax is longer and broader than the abdomen, and in specimens taken about the middle of August the cloacal chamber was distended by three to five large eggs, with the tadpole-shaped embryos nearly developed, while the post-abdomen was quite slender and the ovaries shrunken. Specimens obtained earlier (fig. 22) had the post-abdomen much thicker and filled with the large ovaries, in the upper part of which were eggs in various stages of growth, while the cloacal chamber

Figure 22.—*Amouroucium glabrum* Verrill, enlarged 10 diameters: *a*, anal orifice; *b*, branchial orifice; *c*, branchial sac; *d*, œsophagus; *e*, stomach: *f*, intestine containing fœcal pellets; *g*, anus; *h*, heart; *o*, ovary; *p*, eggs; *q*, eggs containing embryos in process of development; *s*, testes; *t*, spermatic duct,—Original, by A. E. V.

contained but few eggs, in which the development was but little advanced. The post-abdomen is usually but little smaller at base than the abdomen, and tapers gradually to the obtuse end; its length is generally less than that of the thorax and abdomen taken together, but often exceeds it. The stomach (*e*, fig. 22) is short and broad, with numerous longitudinal, glandular ridges. The intestine is large, and usually contains from 7 to 10, large, blackish fœcal pellets.

The branchial orifice (*b*, fig. 22) is surrounded by six, small, tapering papillæ. The anal orifice is somewhat bilabiate, the lower lobe being stout and broad, the upper longer and tapering.

The color of the masses during life, is pale, translucent, bluish white; the branchiæ are light yellow; the stomach dark orange; ovaries yellowish white; the eggs containing embryos bright orange-yellow.

Eastport Harbor and Grand Menan, low-water under stones, to 60 fathoms, stony and shelly bottoms, attached to stones, shells, ascidians, etc., common,—Exp. of 1861, '63, '64, '68, '70.

### *Amouroucium pallidum* Verrill, sp. nov.

Masses sessile, hemispherical or subglobular, usually attached by a large base. Surface generally evenly rounded, sometimes irregular in large specimens, smoothish, but thinly covered with minute, firmly adherent particles of fine sand, which are imbedded in the surface of the common tissue and scattered throughout its substance. The texture is softer and more gelatinous than in the preceding species. The cloacal openings are few in number and irregularly placed, except in small specimens, which usually have but one large central opening. The animals are much smaller and more numerous than in the preceding species, often forming somewhat circular groups of six or eight individuals around the cloacal openings; outside of the circular groups they are usually irregularly scattered, but sometimes form linear series of eight or ten, and in young specimens with but one central opening they often form a larger outer circle, which is near the margin, more or less irregular, and composed of numerous individuals. Except in their much smaller size, the animals resemble those of the preceding species, though they are perhaps a little shorter and thicker in proportion. The post-abdomen, in all the numerous examples examined, was small, thick, obtuse, and decidedly shorter than the abdomen and thorax taken together; it contains few ovules in two series, and often terminates in two slender papillæ.

The larger specimens of this species are ·50 to ·75 of an inch in diameter; the largest animals are ·08 to ·11 long, by ·03 to ·04 of an inch in diameter, but many are much smaller than this; the largest one examined was ·15 long by ·05 of an inch in diameter.

The color of the masses, in life, is pale, translucent, grayish or bluish white, with yellowish white animals.

Eastport and Grand Menan, with the last,—Expeditions of 1868 and '70.

### *Amouroucium pellucidum* Verrill.

*Alcyonidium? pellucidum* Leidy, Journal Phil. Acad. Nat. Sciences, 2nd ser., vol. iii, p. 142, Pl. x, fig. 25, 1855.

"Polypidom translucent white, attached by narrow fasciculated bases, which are extended in a procumbent manner and then expand into wedge-shaped masses, upon the free, flat surfaces of which the polyps are clustered. Polyps with bright orange colored tentaculæ.

Attached to rocks, mytili, sponges, etc., at Point Judith (R. I.); abundant.

The masses of *A. pellucidum* from the white, fasciculated points of attachment to the broad free surfaces are up to an inch in thickness. Although I preserved a number of specimens in fresh sea-water for some days, I could not induce the polyps, if they were such, to protrude from their cells, and I only had the opportunity of examining them in their retracted condition as represented in figure 24, plate x."

The figure referred to very well represents the thorax and abdomen of a species of *Amouroucium*, allied to *A. glabrum* V., except that the longitudinal ribs of the stomach were mistaken for the retracted tentacles of a Bryozoan, and figured as such. The post-abdomen is not shown, and was undoubtedly accidentally broken off in dissecting it out.

The cloacal cavity, or atrium, is represented as distended by four large eggs, containing well advanced embryos; the branchial sac has a broad dorsal and 12 transverse ducts; the intestine is like that of *A. glabrum*, and contained dark fœcal pellets; the branchial opening has six rounded papillæ; the anal has an elongated lobe above it.

Two specimens, dredged at Wood's Hole, Mass. by Prof. H. E. Webster, appear to be identical with this species. These form low, soft, broadly expanded and flat topped masses, up to 2 inches in diameter, and ·50 to ·75 thick, attached by the middle of the lower surface and proliferous around the edge of the base, which is surrounded by young colonies, composed of but few individuals arranged around a central orifice and covered externally with adhering sand. These young colonies are elongated, expanding to the truncate upper end, and ascend very obliquely, the outer ones remaining free, except at base, the inner ones coalescing more or less completely with the central mass. The common tissue of the upper side is very soft, gelatinous, translucent, with but little adhering sand; the sand increases toward the margin, and on the outer and lower sides nearly covers the surface. The individual zoöids are very numerous on the upper side, mostly arranged in rather irregular, elongated, elliptical or oblong systems, composed of many individuals of various sizes. The adult individuals are rather slender and elongated; the slender post-abdomen equalling or exceeding in length the rest of the body, but not more than half the diameter of the thorax and slightly constricted at base. In young individuals, not half grown, the post-abdomen forms nearly half the whole length, and is very slender. The branchial aperture has six, short, round papillæ; the anal is situated a short distance from the end of the body, and has short inconspicuous lower lobes, with an elongated, pointed lobe above. The branchial sac is oblong, with numerous longitudinal and transverse vessels and a broad ventral duct. The stomach is about as broad as long, subglobular, with the ends truncated and the surface covered with numerous, interrupted, longitudinal, glandular ridges. The post-abdomen is nearly filled by the large, elongated ovary, which extends nearly to the posterior end on the dorsal or atrial side, and contains numerous closely packed ovules of comparatively large size, and the conspicuous male organs, extending through the whole length on the ventral or branchial side, in the form of a slightly convoluted, dark colored duct. The posterior end terminates in a small, obtuse papilla. The atrium, or cloacal cavity, contains eggs in which the embryos are well developed, and in some cases the free, tadpole-shaped larvæ. The tunic is speckled with numerous, minute, purplish-brown pigment cells.

One of the larger adult individuals measured ·30 of an inch in length; thorax ·08; abdomen ·06; post-abdomen ·16; diameter of thorax ·031 to ·035; of abdomen about the same; of post-abdomen ·015 to ·020.

### *Amouroucium stellatum* Verrill, sp. nov.

This species forms large, erect, crest-like plates or fronds, attached at the lower edge to stones and pebbles by short root-like extensions; the outer and upper edges are subacute or rounded, divided into two broad, rounded lobes above. The frond is 2·5 inches high, and about the same in breadth, the thickness varying from ·20 to ·35 of an inch. The tissue is firm and cartilage-like externally, softer within; surface smooth and glabrous, without adhering sand. The zoöids are arranged in nearly circular and pretty regular stellate groups, usually containing from six to fifteen individuals, arranged around a central sub-circular orifice; in contraction the position of each individual is indicated by an oval spot, more transparent than the common tissue, with a small flake-white spot around the branchial orifice.

The individual zoöids are elongated and slender; the post-abdomen more slender, usually considerably exceeding in length the rest of the body, and but slightly constricted at base; the thorax and abdomen are shorter and stouter than in the preceding species; branchial sac with about 12 transverse vessels; stomach oblong-oval, with numerous longitudinal glandular folds; intestine large. Branchial orifice with six short lobes; anal orifice terminal or nearly so, close to the branchial, with an acute upper lobe.

Color, in alcohol, milky white, subtranslucent; zoöids yellowish. One of the larger zoöids measured ·31 of an inch in length; the thorax ·085; the abdomen ·062; the post-abdomen ·165; diameter of thorax ·045; of post-abdomen ·025.

Wood's Hole, Mass.,—Prof. H. E. Webster.

This species is easily distinguished from all the preceding by its large, upright fronds, circular systems, and the regular stellate arrangement of the zoöids, and by its firmer texture and smooth surface.

### *Macroclinum*, gen. nov.

Allied to *Aplidium*, forming thick, fleshy masses, of various forms; without cloacal openings or common ducts, each individual having its own branchial and anal orifices, side by side. Systems scattered, usually rather indistinct. Animals elongated, slender; post-abdomen narrow, much longer than the abdomen and thorax taken together, filled with voluminous ovaries, placed on each side of the median duct; eggs small and very numerous; stomach deeply lobed; intestine long, often convoluted; anal orifice terminal or subterminal, near the branchial, subcircular or somewhat bilabiate, the upper side with a rather prominent lobe; branchial with six rounded lobes or short papillæ. Type, *M. crater*.

Savigny included in his genus *Aplidium* two "tribes," each containing several species, but differing considerably in structure. In the first tribe, to which the name, *Aplidum*, should be restricted, the post-abdomen is short and rounded and the ovaries are clustered and contain few large ovules; the anal orifice is on the side of the thorax and distant from the branchial. The second tribe appears to correspond nearly with our genus, *Macroclinum*, the post-abdomen being very long, with the ovaries arranged along each side; but there is considerable diversity in the arrangement of the anal orifices, if

23.

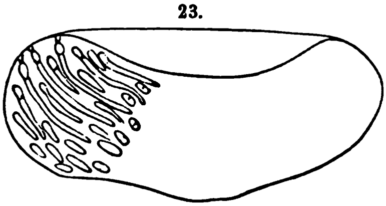


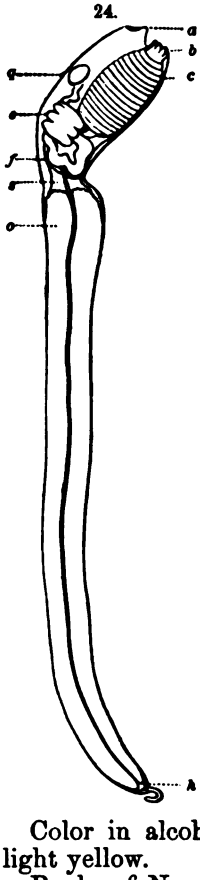
Figure 23.—*Macroclinum crater*, showing in outline a section through the middle, natural size. The animals are omitted on one side.—Original, by A. E. V.

correctly figured. The species are *M. effusum* from the Gulf of Suez, *M. gibbulosum* and *M. caliculatum* from Europe. *M. nutans* (Johns., sp.) from England, appears to be another species.

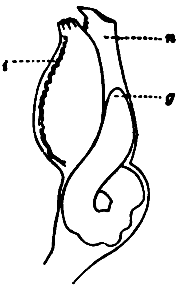
*Macroclinum crater* Verrill, sp. nov. Figures 23 to 25.

This species forms large, thick, gelatinous, but firm masses, which have a circular outline, with the upper surface deeply concave or cup-shaped. The surface is covered with a thin layer of closely adhering grains of fine sand, which are also diffused throughout the mass. The branchial and anal orifices are quite small, close together, and scarcely visible in the contracted state. Animals rather large, and pretty uniformly scattered through the mass, but in some parts forming large, irregular, somewhat circular groups. The thorax and abdomen are comparatively small, together usually less than one-fourth of the entire length; the branchial sac has about 16 transverse vessels, with numerous finer longitudinal ones; the branchial orifice has six small papillæ; the anal is terminal, and slightly bilabiate, with the lobe above it broad and usually recurved at the tip. The stomach, in most of the examples examined, was empty and badly contracted; it appears to be deeply lobed. The post-abdomen is very long and connected to the abdomen by a somewhat narrower, short pedicel. A conspicuous median duct extends the whole length, with the voluminous ovaries on each side. The ovules are very small.

24.



25.



The common mass is 1·75 inches in diameter, and 1 high; the largest individuals are ·50 to ·65 of an inch long, and ·06 to ·07 in diameter, at the thorax.

Color in alcohol translucent yellowish white; the animals light yellow.

Banks of Newfoundland,—T. M. Coffin.

Figure 24.—One of the individual animals, extracted and enlarged 7 diameters; *a*, anal orifice; *b*, branchial; *c*, branchial sac; *e*, stomach; *f*, intestine; *h*, heart; *o*, ovary; *q*, egg in process of development in the cloacal chamber or atrium; *s*, spermatic duct.—Original, by A. E. V.

Figure 25.—View from the opposite side, showing the thorax and abdomen of another individual, enlarged 10 diameters; *g*, termination of the intestine, which is filled with fœcal matter; *i*, ventral duct of the branchial sac; *n*, cloacal chamber.

With the last species Mr. Coffin otbained another, which is not well enough preserved to admit of accurate determination. It may be a species of *Amouroucium*, or another *Macroclinum*. It forms broad incrustations, 2 or 3 inches across and about ·25 thick in the center. The marginal portion is thin and covered with adherent grains of sand; the central part is smooth and glabrous, slightly convex. The zoöids are about ·30 long, with a long post-abdomen, which is not pedicellate, resembling that of *A. glabrum*.

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## ART. XLV.—*Amazonian Drift*; by Prof. CH. F. HARTT, of Cornell University.

PROF. AGASSIZ has claimed that the structure of the Amazonian valley is very simple; that, from one end to the other, there was laid down in the fresh water lake formed by the damming up of the mouth of the valley, by a glacial moraine, beds of sands, clays and sandstones, filling the valley to the height of several hundred feet above the present level of the river; that, from the bursting of the barrier and the draining of the lake, the uppermost beds were denuded down, and swept off from over a very great part of the valley, leaving only isolated outlines as a series of table-topped hills or serras, like those of Almeirim, Paraúquára, Velha Pobre; that the lake, reduced to a lower level, then threw down over the denuded portion, a sheet of clay, the river finally cutting its channel through this clay and the underlying sand, &c. He did not claim to have found grooved or striated surfaces in the Amazonas, and the only instance of supposed erratics he gives is that of the diorite found on the flanks of the serras of Ereré. Prof. Agassiz gave as a type of the table-topped hills the serra just mentioned. Last summer, in making an examination of the lower part of the Amazonian valley, I visited Ereré and spent a month in its vicinity going over the ground on foot in every direction, and in the most detailed way.

The serra does not belong to the system of table-topped hills of which Paraúquára and Velha Pobre are examples. These last and the range of highlands on the south of the Amazonian valley are composed of soft materials; they are perfectly flat on top and descend on all sides by a steep even slope; moreover, the strata composing them are horizontally disposed.

Ereré is a short, narrow, irregular ridge about 800 feet in height, several hundred feet lower than the table-topped hills, the top being anything but horizontal. The strata composing it are principally a heavy-bedded coarse white sandstone exceedingly hard, with bands of indurated feldspathic clay. These beds dip to the southeastward (approximately), with an angle in some places of 15 or 20°.

On the northern side of the serra and extending close up to its base is an extensive plain composed of a series of coarse shaly sandstones, shales, and cherty beds, quite horizontal, and not participating in the disturbance which the strata of the serra have suffered. These beds contain trilobites of the genus *Dalmanites*, with species of *Spirifer*, *Orthisina*, *Chonetes?*, *Discina*, *Lingula*, *Leptocœlia*, *Tentaculites*, &c. Specimens of these have been submitted to Prof. Hall who writes me that they indicate a horizon equivalent to the Upper Helderberg. The conclusion seems inevitable that the serra is pre-Devonian in age. The Devonian rocks of the plain are broken through by a perfect net work of dikes of trap now decomposed. The end of a curious low ridge that runs off at right angles from the serra consists of a large mass of trap. This has given rise to a great number of boulders of decomposition which lie on the surface or are buried in decomposed rock. They have been carried down the beds of torrents but they are nowhere erratics. To speak broadly, I did not see either at Ereré or in any part of the Amazonas, anything that would suggest glacial action. So far as the province of Para is concerned, the clays, sands, &c. forming the lower lands are far from being uniformly distributed, and are very puzzling to study. The arrangement of the materials varies in different regions, and many of the deposits are local. In part, the lower lands are formed from the wearing down of the great sheet of clays, &c., of which the Almeyri~~ne~~ hills are m / relics, in part they are of brackish or fresh water origin when the river stood at a greater height; and much is the very recent work of the river. The variegated clays belong to several distinct epochs. Superficially examined they appear to be universally distributed, but it is very far from being the case. It is impossible to recognize beds of clay in the Amazonian valley simply from lithological characteristics. It is sufficient to say that variegated clays of exactly the same appearance and structure, because formed of materials reworked or drawn from the same source, occur in the Devonian, Carboniferous, Tertiary and in half a dozen successive formations of recent times.

I have referred the beds of the table-topped hills to the Tertiary. Some of the clays and sandstones of the lower Amazonas may also be later Tertiary; but many are undoubtedly recent, they are full of leaves of modern species. Near Santarem I found a bed of recent fresh water mussels, *Castaleas*, *Hyareas*, *Unios*, &c., whose upper limit was at least fifty feet above the level of the highest Amazonian floods. This is in exact accord with the facts I have given elsewhere—being on the late rise of the Brazilian coast, a rise which extended itself into the interior. Before this rise the land stood much lower than at present;

the island of Marajó did not exist, and the Amazonas formed an estuary opening widely to the sea. Not only were the lower plains of Pará flooded, but immense tracts of the province of Amazonas were covered with water. How far this salt water penetrated I do not know, but the shells of Pebas show that at one time its influence may have extended far up toward the Andes. At the time of the growth of the Santarem shells the water may have been brackish. With the gradual rise of the continent, not of the Andes alone, the fresh waters drove down the salt, the narrow river bed with its numerous channels was hollowed out of the emerging bottom, the sea began to attack and cut away the coast lands, and the present estuary condition of the mouths of the great river was brought about. I have not yet told half the story of the history of the Amazonian valley. It is by no means a simple one, and there are more episodes in it than we have hitherto dreamed. The Amazonas is a world, and no one man need hope to exhaust its wonders.

Cornell University, Ithaca, N. Y., Feb. 23d, 1871.

## SCIENTIFIC INTELLIGENCE.

### I. CHEMISTRY AND PHYSICS.

1. *On some Lecture-experiments.*—(1.) To show the reciprocal combustion of the elements of water, JULIUS THOMSEN proceeds as follows: two narrow tubes of platinum, a centimeter long by a millimeter in diameter, formed by rolling up a piece of foil, are melted into the ends of two narrow glass tubes, and serve for the jets. These glass tubes pass through a rubber cork, distant from each other about a centimeter. One of them communicates with an oxygen gas-holder, the other with one containing hydrogen. The cocks of both are opened, the hydrogen is ignited and the stopper with its tubes, is introduced into a wide glass tube 10 or 15 centimeters long, slightly constricted at its lower end, and drawn to a narrow opening above. The hydrogen now burns in the oxygen, the platinum jets protecting the tubes. If now the oxygen be gradually shut off, a point will be soon reached where the amount present will be insufficient for the combustion of the hydrogen; the flame expands, and apparently disappears, but in an instant re-appears upon the oxygen tube, the oxygen now burning in hydrogen. On admitting more oxygen the flame passes over again to the hydrogen tube as at the first. This exchange may be repeated as often as is desired without extinguishing the flame and without danger, if the oxygen be let on and cut off with sufficient slowness.

(2.) To show that oxygen may burn with a smoky flame, Thomsen uses the vapor either of turpentine or of benzol. Some benzol is heated to boiling in a long-necked flask closed with a stopper, through which passes a central tube a centimeter in diameter, and also a small lateral one, bent to one side. The vapor is ignited at the mouth of the large tube, and a small tube recurved at its lower end, through which a stream of oxygen is passing, is immediately inserted, the opening being closed by a cork which slides upon the small tube. The flame of the benzol vapor is thus extinguished and the oxygen burns in the vapor in the flask, with a smoky flame. The excess of vapor passes off through the small lateral tube.

(3.) The processes of oxidation and reduction and the consequent changes in weight, Thomsen shows thus: cupric oxide is mixed with gum-water to a stiff paste and formed into cylinders, flattened on their sides, about a centimeter in diameter and 3 centimeters long. These are then dried, ignited, and reduced by hydrogen at the lowest temperature possible. A cylinder of metallic copper is thus obtained, very porous but sufficiently coherent to retain its form. These are wound with platinum wire, the two ends of which are melted into glass tubes by which they are handled. Two small tubulated glass bells are filled, the one with hydrogen, mouth downward, the other with oxygen, mouth upward, by displacement, the gases being allowed to flow slowly into them during the experiment. One of the copper cylinders is warmed to expel moisture, and immersed in the oxygen; it is raised at once to ignition and remains so until completely oxidized. It is then plunged into the bell-jar of hydrogen; it again begins to glow, the water formed runs down the side of the bell, and the cylinder is reduced to copper again. These combustions, the one in oxygen, the other in hydrogen, both evolving much light and heat, are very striking; and as the increase in weight of the cylinder by oxidation is almost a gram, it may be shown on an ordinary balance.—*Ber. Berl. Chem. Ges.*, iii, 930, Dec. 1870. G. F. B.

2. *On Ozone and Antozone.*—ENGLER and NASSE have investigated the production of antozone by the method of Meissner (this Journal, II, xxxvii, 325, xxxviii, 18, l, 213). They used an ozonizing tube 85 centimeters long, containing 28 wires enclosed in glass, and a coil sufficiently powerful to render the entire bundle of electrodes luminous in the dark. If the ozonized oxygen be passed through a U-tube 30 centimeters long and one centimeter in diameter, containing zinc-sodium in fragments, the ozone odor disappears completely. If the same tube be placed between the potassium iodide solution and the water over which the cloud appears, the formation of the cloud is not interfered with; thus showing that it is only the ozone and not the antozone which is destroyed by the zinc-sodium. Since Meissner concedes that the ozone must be removed to detect the antozone, it follows that were the antozone formed in the electrizing tube, the gas issuing from it after passing through the zinc-sodium tube and thus being deprived of ozone, should, on bubbling through water, produce a cloud; but this the authors find not to be the case. Moreover, they show that if the stream of oxygen issuing from the potassium iodide solution be passed through a tube 1·3 meters long,

filled with fused calcium chloride, the antozone disappears; while ozone passed through such a tube is unaffected. But if the gas from the ozonizing tube be passed directly through this calcium chloride tube, then through potassium iodide solution and then through water, the cloud appears with full strength. Engler and Nasse hence infer that the antozone is formed when the ozone is destroyed in presence of water; and only then. Whence they conclude with v. Babo and Weltzien, that antozone is only hydrogen peroxide. In support of this view they give the following experiments: (1.) The stream of electrized oxygen, deozonized by a solution of potassium iodide, was passed through a spiral tube 1·5 meters long, and found to give the mist on passing through water. This spiral was then heated in a zinc chloride bath; as the temperature rose, the mist formed became less and less, disappearing completely at 170°, and returning again as the tube cooled. (2.) The stream of deozonized oxygen was passed through a short tube containing fragments of potassium hydrate, and then through four narrow tubes 60 centimeters long filled with glass-fragments; but its mist-forming power was hardly weakened; when these tubes were cooled to —20°, however, no mist appeared on passing it through water; and when two narrower and empty tubes were used, and the stream of gas continued for 24 hours, water condensed in them which gave the reactions of hydrogen peroxide. In conclusion, the authors show that the division of oxides by Schönbein into ozonides and antozonides is not well founded.—*Ann. Ch. Pharm.*, cliv, 215. G. F. B.

3. *On the Peroxides obtained by Electrolysis.*—Wernicke has analyzed the metallic films deposited upon the positive electrode in the electrolysis of solutions of certain metals. The following are his conclusions: (1.) The so-called peroxides, deposited by electrolysis from neutral or alkaline metallic solutions, are hydrates of the composition $\mathrm{R''\Theta, H_2\Theta}$ or $\mathrm{(R_2)^{vi}\Theta_3, 2H_2\Theta}$. (2.) The composition and the specific gravity of the bodies examined are as follows:—

| | | | |
|---|---|---|---|
| Perplumbic hydrate, | | $\mathrm{Pb\Theta_2, H_2\Theta}$ | 6·267 |
| Permanganic | “ | $\mathrm{Mn\Theta_2, H_2\Theta}$ | 2·564—2·596 |
| Perbismuthic | “ | $\mathrm{Bi\Theta_2, H_2\Theta}$ | 5·571 |
| Percobaltic | “ | $\mathrm{Co_2\Theta_3, (H_2\Theta)_2}$ | 2·483 |
| Pernickelic | “ | $\mathrm{Ni_2\Theta_3, (H_2\Theta)_2}$ | 2·741 |

(3.) In thin layers these bodies exhibit the most beautiful interference-colors, which may be made available for the estimation of the refraction and dispersion of light. For purposes of technical metallochromy, the new colors of percobaltic hydrate are particularly to be noted, on account of the facility of their production and their permanence. (4.) All of these compounds are formed only with a weak current. If it be too strong, the precipitate thrown down on the positive pole contains less oxygen; until with a certain strength of current, oxygen only is evolved, the metal in the solution being unaffected. In this latter case the author supposes hydrogen peroxide to be formed, which decomposes the metallic perhydrate.—*J. pr. Ch.*, II, ii, 419, Dec. 1870. G. F. B.

I. *A Laboratory Text-book of Practical Chemistry; or Introduc- n to Qualitative Analysis.* A guide to the course of Practical struction given in the Laboratories of the Royal College of emistry. With 90 engravings. By Wm. G. Valentin, F.C.S. o, pp. xii, 380. London, 1871. (John Churchill & Sons).—One the chief difficulties, which beset the chemical instructor at the esent day, is that of satisfactorily combining didactic with actical instruction; of teaching by text-book recitation on the e hand, and at the same time, of instructing by laboratory perimentation on the other. While it is unquestionably ie that Chemistry cannot be properly learned solely by com- tting a volume to memory, it is equally true that it cannot mastered by working solely with apparatus. Both the in- llectual and the manual discipline are necessary. In the book fore us, the author, fully recognizing these two phases of the bject, has attempted to combine them. We have here not a y enumeration of facts, to be proved by experiment and then ored up individual and alone. Nor on the other hand, have we book to be memorized and recited from, parrot-like. "It has en the author's endeavour," he says in his preface, " to enter only far into theoretical considerations as was absolutely necessary explain the laws which govern chemical changes, and to make e beginner practically familiar with the properties of elementary atter, and the most important forms of combination."

The work is divided into two parts. Part First consists of " 100 ementary exercises, introductory to General Chemistry and to ualitative Chemical Analysis." Part Second is a course of Quali- tive Analysis proper. In the first part, the student begins by rforming simple and clearly discribed experiments with hydro- n and continues with oxygen, sulphur, chlorine, etc., and their mpounds, the theoretical knowledge being gradually worked as it is required. In the second part the usual division of the ases and acids into groups is followed, the whole being well ranged. Frankland's notation, wherein every chemical com- ound is formulated upon the type of the highest equivalence of s dominant atom, is used throughout. The atom of highest mbining power in every molecule, is written first in heavy full- ced type, thus, $\mathbf{N}O_2Ago$, $\mathbf{S}O_2Zno''$, $\mathbf{B}Nao_3$, etc. Graphic for- ulas are also freely employed. At the end of each chapter in oth parts, are questions for examination, which are remarkably ll and thorough. The reactions in all cases are given, and all e facts which help the student to a complete knowledge of the bstance under examination are fully stated. Frequent examina- ons are recommended, and these are to be conducted like recita- ons. Copious tables in the appendix contain a condensed state- ent of the analytical processes, of the solubilities of salts, and f the metric system of weights and measures.

We have rarely seen a better book to teach from than this. In s plan and the mode of carrying it out, its clearness, thorough- ess, accuracy and attention to detail, it is, in our view, one of the best works of its kind in the English language. The wood-cuts are excellent and the style of the book is mechanically unexceptionable. G. F. B.

5. *A Series of Chemical Problems for use in Colleges and Schools. Adapted for the Preparation of Students for the Government Science and Society of Arts Examinations;* by T. E. THORPE, Ph.D., Professor of Chemistry in Anderson's University, Glasgow, with a Preface by Professor ROSCOE, B.A., Ph.D. F.R.S. 67 pp. 16mo. London, 1870. (MacMillan; Manchester, James Galt & Co.)—This little volume contains an excellent collection of practical problems, such as every chemist has to deal with, founded upon the modern nomenclature and notation, with simple formulæ for their solution, and systematically and very clearly arranged. The best and most recent determinations are employed as data, and an appendix contains a number of very useful auxiliary tables of physical and chemical constants, logarithms, &c. The exercises relating to specific heat, latent heat, calorific power, and calorific intensity are especially fresh and valuable. The volume is well calculated to serve both as an aid to the student, and as a practical reference book. A. W. W.

## II. GEOLOGY AND NATURAL HISTORY.

1. *California Geological Survey.*—Ever since the first inauguration of this great work (in 1860), we have from time to time given our readers accounts of its progress, reporting the results of its explorations and the appearance of its publications, calling attention to the high ability and excellent spirit with which its labors were carried on, and expressing our hearty desire for its continuance, and completion upon the scale on which it was begun. Only two months ago (above, p. 70), its last published report was noticed in this Journal—the first volume of Ornithology, containing the land birds of the western side of the continent. Since then, the edition of the same with colored figures has appeared, and fully justifies the expectations entertained of it. The plan of giving highly colored illustrations in the text itself, on the same page with the letter-press, is quite new, and its success, which is complete, will be likely to make an era in the history of illustrated works on natural science. The admirable quality of the paper used, and the skill of the colorist, have united to produce a result which must satisfy the most critical taste.

The second volume of Ornithology, which will contain the water-birds of the whole country, is in process of preparation. The volume of Conchology, which Dr. Carpenter undertakes, is likewise begun; and Prof. Brewer of Yale, formerly assistant on the survey, is rapidly working up the botanical material for publication, aided by Prof. Gray, and by others specially qualified for the work. The abundant collection of mammalian fossils is committed to Dr. Leidy for treatment. The fossil botany is undertaken by Prof. Lesquereux. The volumes already issued contain descriptions and figures of the invertebrate fossils by Mr. F. B. Meek and Mr. W. M. Gabb. It thus appears that Prof. Whitney has called to his aid the best available talent in working out the results of the survey in special departments. Meantime, the field-work, and the elaboration of the geological and topographical data collected, are going on rapidly under his direction.

The necessity of preparing maps for the accurate delineation of the geology of a vast state of almost unknown geography, has led to an expansion of the topographical work far exceeding what was anticipated, and constituting a step of very great importance in the history of American geography. Accurate detailed maps, from actual surveys, of extensive inland regions, including grand mountain features, had not been produced before in the country, at least on anything like the same scale. Nor has the beneficial activity of the survey in this direction been limited to California; the survey of the 40th Parallel is to be accounted one of its fruits, the two heads of the latter, Messrs. King and Gardner, having begun their Western work in California under Prof. Whitney, and undertaken their survey in continuation and completion of his. Of the maps of the California survey, there have appeared hitherto those of the Yosemite valley and of the High Sierra in its vicinity (in the Yosemite Guide Book), and that of the region adjacent to the Bay of San Francisco, the last on a scale of two miles to the inch; a much larger map, including about 60,000 square miles of the central part of the State (occupied by more than nine-tenths of its population), is far advanced, one of its four sheets (the S.W. corner) being already engraved, and a second (the S.E. one, containing the highest part of the Sierra) in the engravers' hands. This is on a scale of six miles to the inch; it will be issued in duplicate, as geological and as a topographical map. Another, of the whole State, at eighteen miles to the inch, is finished, and is intended to serve as a preliminary geological map, and to accompany the second volume of geology, of which the printing will be begun next summer. Among the regions which have been recently receiving particular attention is that of the ancient river-channels, on the western slopes of the Sierra, which a party has for a long time been engaged in exploring and mapping, and on which a full report is soon to be made; also, the White and Inyo ranges of mountains, east of the Sierra and of Owen's valley; and the vicinity of Clear Lake, in the northern coast ranges.

We cannot express too strongly our sense of the importance of this survey, and of its value to the people of the whole country as well as of the State which it particularly concerns. That, after its temporary suspension (1868–70), it was taken up again and vigorously pushed, is highly creditable to the enlightenment of the California people; and it is not to be believed that they will again falter in the support of a work which is bringing them so much honor throughout the world, and helping to lay a sure foundation for the future successful development of the resources of the State.

2. *Geological Survey of Illinois: A. H. Worthen, Director.* Vol. IV. *Geology and Paleontology. Geology, by* A. H. Worthen, *and Assistants* H. M. Bannister, Frank H. Bradley *and* H. A. Green: *Paleontology, Section* 1, *Descriptions of*

*Vertebrates, by* J. S. NEWBERRY *and* A. H. WORTHEN; *Section 2, Description of Plants, by* LEO LESQUEREUX. 508 pp. royal 8vo, with 31 plates.—Much has been done in this country in the way of Geological Surveys. Yet only two States east of the Rocky Mountains have carried forward such surveys to anything approaching a worthy completion. These two States are New York and Illinois. Fortunately they supplement one another, so that a geologist, by possessing the reports of the two, when they are finished, will have quite a good account of the rocks and fossils of the whole range of the Paleozoic formations of the country. New York carries forward the subject to the Coal formation, while Illinois gives much that is new from the earlier limestones, and continues the geology through the Carboniferous period, in which part of the series the State is particularly rich.*

The fourth volume just issued is, like its predecessors, a handsome volume, and full of valuable material. Most of the counties here reported on are within the coal basin; and the reports are full of local details of Coal-measure sections—highly important to the local student and to capitalists interested in coal and iron, but including few matters of general interest. A hasty glance shows that the coal tonnage of these counties is immense, being approximately as follows:—Adams county, 830 millions of tons; Brown, 400 millions; Schuyler, about 1750 millions; Fulton, 7000 millions; Morgan, 3000 millions; Cass and Menard, 4000 millions; Tazewell, McLean, Logan and Mason, 30,000 millions; Grundy, 900 millions; Will, 66 millions; Kankakee, 40 millions; Vermillion, 4000 millions; Edgar, 6000 millions; Champaign and Ford, 10,000 millions: total, 70,000 millions of tons.

As matters of especial scientific interest, in the county reports, we note particularly various details and discussions touching the Loess; the Drift, with its included or antecedent beds of ancient swamp muck; the shallow artesian wells of the gravel of Iroquois county; the ancient channel [probably of a glacier] now filled with Drift, which runs south from the southern extremity of Lake Michigan; the outlines, level and drainage of "Lake Kankakee;" and the old outflow of Lake Michigan by the valley of the Desplaines and Illinois rivers. It is to be regretted that a map proposed for the purpose of showing details on these latter points could not be published with the volume, "for the lack of means to defray the expense of engraving," even though "the most essential parts of it will be transferred" to the large map of the entire State, now in course of preparation. Details are given, touching the unconformability of the Coal measures with the Subcarboniferous, and of the Devonian (or Subcarboniferous) with the Silurian.

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* The most of the other States have had surveys in progress; but, in general, in spite of the earnest protest of those interested in the work, they have been cut short when only a fair beginning had been made. Pennsylvania has done the best among these States; but still its extended Report, very valuable as far as it goes, includes no volume illustrating with plates the fossils of its rocks, the Coal plants excepted. Massachusetts has done much, but there is much more to be done; and the same is true of other States.

The equivalency of the different coals of the Illinois and Wabash valleys seems to be still in question; and we shall look with great interest for the thorough discussion of this subject which Prof. Worthen will doubtless give before closing his work.

The second part of this volume is occupied with descriptions and plates of fossils—Fishes and Coal-plants. Many new and interesting forms are described and figured. Prof. W. also notes the existence in his collections of enough of ichthyic fossils, as yet undescribed, to carry his catalogue of Illinois Carboniferous fishes to "something over two hundred species."

Mr. Lesquereux, after describing many new Coal-plants, and adding much to our knowledge of previously-described species, closes with an interesting discussion of facts regarding our American Coal-flora, which we shall notice more fully hereafter.

Prof. Worthen promises to complete this series of reports with two more volumes, most of the material for which is ready for the printer. We learn that the *fifth* volume will contain plates of the most important and beautiful series of Carboniferous crinoids and other echinoderms that has ever been figured or described. Very many of the figures have been carefully drawn, with many details of their structure, by Mr. F. B. Meek, and the remainder by Mr. Charles K. Worthen (son of the Director of the Survey), under Mr. Meek's direction. Including some of fishes there will be about forty plates.

3. *Burning of the State Geological Rooms at Springfield, Illinois.*—On the night of the 22d of February, (after the 4th volume of the Illinois Geological Report, above noticed, was received by us,) the building containing the State Geological Rooms and Collections was burned. The fire took in a book-bindery adjoining, and, "in five minutes after the alarm was given, the upper part of the building was a sheet of flame." Prof. Worthen's son, who was sleeping that night in the office, succeeded in removing all his father's library and private cabinet, before it became necessary for the engines to play upon the building. The State Collections, which contained the most complete series of Carboniferous fossils in the country, if not in the world, besides numerous other species, and many kinds unknown elsewhere, were greatly damaged by water and by hasty removal, and very many fine specimens were ruined. Since the fire they have been transferred to the basement of the new Post-Office building, which, as it is fire-proof, is safe against such disasters, and where they ought to have gone long before the fire. Fortunately, the copies of the 4th volume were in the hands of another book-binder and escaped.

This is another warning to all States, Societies or Institutions, having valuable collections, libraries or records; there should be no rest among the friends of learning until fire-proof buildings are provided for such objects. The money argument, that such a collection as that of Illinois would bring in the market over $20,000, has much force. But this amount in dollars is only a fraction of the real value to science, or to the people of Illinois.

4. *Report of the Geological Survey of Iowa*, under Prof C. A. WHITE, Vol. II, 444 pp. 8vo.—The first volume of this report is noticed on page 217. The second volume contains a well prepared and instructive chapter, of 186 pages, on the Geology of the Middle region of Western Iowa and other counties by O. H. St. John, and reports on northwestern, and the middle region of northern, Iowa, and on the Coal counties, by Professor White, occupying nearly 100 pages. Prof. White next treats of the economical products of the State, exclusive of coal. Then follows the valuable chemical report of Prof. Rush Emery, containing analyses of rocks, coals, peats, etc. Those of coals are numerous; they have special reference to the economical value of the coals, and give the amount of moisture, volatile combustible, fixed carbon and ash. Prof. Emery compares the analyses with those of the coals of Illinois, and observes that the amount of moisture is perhaps a little in favor of the Iowa coals; the amount of ash is almost the same; that of fixed carbon is largely in favor of Illinois; while that of the total combustible matter is in favor of Iowa. The volume closes with a table of altitudes, and a catalogue of birds. The volume contains also a colored geological map of the State by Prof. White.

5. *Historical notes of the Earthquakes of New England*, 1638—1869; by WILLIAM T. BRIGHAM, A.M., A.A.S. 28 pp. 4to. From the memoirs of the Boston Society of Natural History, vol. ii, page 1.—This important memoir by Mr. Brigham aims to give a list of all the well authenticated earthquakes that have occurred in New England, with such notes as could be gathered from the records of the time. The number catalogued as having been felt over New England since 1638, eighteen years after the landing of the Pilgrims at Plymouth bay, is 227. Besides these, four earlier ones are mentioned from the traditions of the Indians. These were distributed through the months as follows:

Oct., 19; Nov., 29; Dec., 22; Jan., 20; Feb., 36; Mar., 22..148
April, 9; May, 13; June, 14; July, 13; Aug., 15; Sept., 10.. 74
No month given,.......................................... 9

A considerable number of these earthquakes were felt over all New England, some of them also over Canada, and a few had wider limits. Many of them were comparatively local in their range. Three such local regions are deduced by Mr. Brigham from the catalogue. These are—1. A region in Canada, somewhat elliptical in form, with the city of Montreal as its western focus. 2. A region around the mouth of Merrimack river, in New Hampshire and Massachusetts and extending to Boston. 3. A region smaller than either of these, around New Haven, Lyme and East Haddam.

The author makes some suggestions with regard to the origin of the earthquakes, proposing to take up the subject in full at another time. He thinks it probable that there have been volcanoes somewhere in New England, prefacing his remarks by the statement that our Geological Reports have often been prepared by those who had never studied active and extinct volcanoes, and adding a remark implying that if Percival had ever "seen a volcano," he would have found them in the trap region of Connecticut. In reply to this we would state that no region of igneous rocks, volcanic or otherwise, was ever studied with more care, or with a more exact determination of the facts, than that of Connecticut by Percival. We have followed him over and among the various trap ridges of the Connecticut valley, and know positively that the trap eruptions were in all cases, eruptions through fissures, as Percival states, and not by volcanoes. We deprecate this throwing doubt over the accurate observations of others, by one who acknowledges that he knows nothing about the facts.

There are beds of scoriform rock in the Connecticut valley among the stratified beds in the vicinity of the trap. They occur near New Haven. A remarkable locality exists in Durham, on the Air-line railroad, under a bridge just east of Reed's Gap (a gap in the trap hills). At this place, the layer *seems* to be made up of large masses of scoria, some of them from four to six inches in diameter. But on a careful examination by the writer, the rock proved to be nothing but a scoriform sandstone, particles of quartz, feldspar and other ingredients of the Mesozoic sandstone being visible throughout the scoria masses, and manifestly constituting them. It is obviously a bed, like others at New Haven, through which steam penetrated freely during the trap eruption.

Mr. Brigham also suggests that the formation of trap dikes may now be going on, from time to time, at various depths below the surface; and "that the high temperature they bring in contact with the cold rock, through which they break, or into whose cavities they run, produces the tremors and disturbances we call earthquakes." But there is not an observed fact that authorizes us to believe that any eruption of trap has taken place in New England since the Mesozoic era. Moreover, earthquakes are not produced by the escape of igneous rock. An earthquake is the jar from sudden fracture or displacement; it matters nothing whether igneous ejections follow or not. The breaking of the rock begins the "tremor" if not already initiated. The earthquakes of New England may have resulted from a slight yielding to tension in the rocks somewhere beneath the region shaken, a tension that may be a consequence of former upheavals or subsidences of the region, or of unappreciated movements that are now in progress; or possibly of contraction or expansion below due to subterranean change of temperature; and some of the more local may come from a yielding to gravity in rocks beneath, if openings or cavities there exist. J. D. D.

6. *Preliminary notice of a new species of Trimerella, from Ohio;* by F. B. MEEK. (Communicated by the author).—Among the fossils obtained by the Geological Survey of Ohio (now in progress under the direction of Prof. Newberry), and handed me for study, there are from the Niagara group some large casts of a *Trimerella*, which I had thought might be a variety of *T. grandis* Billings. On comparing them recently with Mr. Billings's typical specimens of that species, I have found them quite different and distinct. They are proportionally much broader shells, and differ in having the beak of the dorsal valve strongly incurved beyond

the plane of the connecting edges of the two valves. They are also more convex, the ventral valve is more arched, and the rostral davity of the dorsal valve deeper. The whole length of the shell must have been nearly 4 inches, the breadth 2½ inches, and the co vexity about 1¼ inches. A description, with illustrations of the species (which I propose to call *Trimerella Ohioensis*), will appear in the Ohio Geological Report.

7. *The Phosphate Rocks of South Carolina;* by Francis S. Holmes, Charleston, S. C.—In the notice that has been given of this pamphlet, its views are not correctly represented. The author observes that the "Phosphate rocks" have been derived by denudation from an older formation, viz: the Eocene Marl. He states further that the beds of "phosphate rocks" thus produced contain the remains of various Post-pliocene land-animals, and are therefore Post-pliocene in age. He concludes that in that era the regions of these deposits along the coast were in the condition of salt-lakes or lagoons and were frequented by the Post-pliocene land-animals—"the Elephant, Mastodon, Rhinoceros, Megatherium, Hadrosaurus [?, the Hadrosaurus is a Cretaceous reptile], and other gigantic quadrupeds"—in great numbers, periodically, to sip the brine, or later to lick the salt, the areas serving as "salt-licks;" and that these animals left there their excrements and bones. The author holds that the former was the principal source of the phosphatic material, the bones adding only a small part; and that the excrements of birds did not contribute to the formation. He also remarks upon the change of the carbonate of lime of the rocks into phosphates by the waters percolating through them from the overlying fœcal layer,—a process referred to by J. D. Hague in this Journal, vol. xxxiv (1862), and by Mr. Julien in vol. xxxvi (1863), and vol. xl (1865).

8. *South African Diamonds.*—The diamond shipments from South Africa during the last two years have been as follows, according to the official return published in the *Standard and Mail* of the 4th of January: Shipped during 1869, 141 diamonds, valued at 7,405*l.*; during 1870, 5,661 diamonds, valued at 124,910*l.* To these must be added the "Star of South Africa," and some others sent by private means to Europe, valued at nearly 15,000*l.* A large number of the Cape diamonds now in London are of an inferior description; and we are informed by a large dealer in this gem that none of them are equal to the old Golconda gems.—*Athen.*, Feb. 18.

9. *Sciadopitys verticillata* of Siebold and Zuccarini is a Japanese Coniferous tree of considerable interest, as well from the peculiar structure of its leaves, as from the striking appearance of the verticillate foliage. Von Mohl, in the first two numbers of the *Botanische Zeitung* for 1871, has made an interesting exposition of the peculiarities of these leaves, and of the light they throw upon the morphology of Coniferæ. The cotylodons and the succeeding whorl consist of normal leaves. The rest of the foliage consists of double leaves, i. e. of two leaves united into one body emarginate at the apex, and subtended by a minute scale;

each, therefore, answers to a bundle of pine-needles, on a secondary axis, but without the sheath of scales, and the pair of leaves connate. Mohl shows that the anatomical structure bears out this view, and, moreover, that these two lateral leaves are so united that their upper face is turned downward as respects the main axis, the lower upward. Now Braun and Caspary, as is well known to morphological botanists, have drawn from the study of abnormal cones of Larch the conclusion, that the ovuliferous scales of *Abietineæ* equally consist of two connate carpellary scales; and these also present their normally upper face downward, their lower face upward; so that it is what answers to the under surface of the leaf that bears the ovules, as it is the under surface that bears the fructification in Ferns. A. G.

10. *Musci Appalachiani: Specimens of Mosses collected mostly in the Eastern part of North America;* by C. F. AUSTIN. 1870.—We have thus far seen only the *tickets* of this collection, which are collected to form a pamphlet of 92 octavo pages, including a complete index. There are 450 numbers, and a few intercalations, and there are Latin characters of a considerable number of new or critical species. Although the collection of the Mosses themselves is, we believe, not yet issued, it is likely to be so before this notice is published; and we will take the liberty to announce the publication as one of large extent and of unsurpassed value. The limited number of sets makes it likely that they will be taken up almost at once. A. G.

11. *Report on the Progress of the State Geological Survey of Michigan;* presented Nov. 22, 1870, by ALEXANDER WINCHELL, Director. 64 pp. 8vo. Lansing, 1871. Published by authority of the State.—We propose to notice this report in the following number.

12. *Annual Report of the State Geologist* [G. H. COOK] *of New Jersey, for the year* 1870. 72 pp. 8vo. New Brunswick, 1871.—This report is occupied mainly with matters of economical interest connected with soils, reclaiming marshes, fixing shore sands, etc.

## III. ASTRONOMY.

1. *Transit of Venus in* 1874.—The following letter from Prof. ASAPH HALL, of the U. S. N. Observatory, dated Feb. 25, 1871, is gladly published, in view of the importance of early and full deliberation with respect to the approaching transit of Venus.—EDS.

I would ask the attention of American astronomers to the approaching transit of Venus, that will occur Dec. 8th, 1874.

The memoirs published by Airy, Hansen, Oppolzer and others on the theory of this transit, and the maps which they have given for the selection of observing stations, render superfluous, perhaps, anything further on this part of the subject. What seems to me of the greatest importance is the union of all the American astronomers, in order that they may act in harmony and so that their observations at the various stations shall be made with similar instruments and in accordance with a preconcerted plan. The importance of such united and harmonious action will be acknowledged, I think, by any one who has ever reduced and discussed observations of this kind, for example, those of Mars made in 1862. I am confident that it is only by such action, and by careful, thoughtful and deliberate preparation, that the American observers can obtain results comparable in accuracy with those that will be obtained by the German expeditions. I venture, therefore, to suggest the following plan of operation.

Let the National Academy and the American Association for the Advancement of Science, at their next meetings, invite the attendance of the Directors of all the astronomical observatories in the country, and of all who are engaged in astronomical pursuits, theoretical or practical. Let these astronomers discuss and decide upon the stations to be occupied and the methods of observing the transit. They should appoint committees who should have charge of procuring instruments, selecting the observers and making preparations for paying the expense of the expeditions. Besides the scientific advantages to be gained, the hearty coöperation of our astronomers, in the solution of such a problem, will bring about mutual acquaintance and recognition of each other's abilities.

The first meeting of the commission convoked by Chancellor Bismarck for considering the approaching transit of Venus was held at Berlin, Oct. 25th, 1869. This commission consists of Hansen, president, and of Argelander, Paschen, Bruhns, Förster, Auwers and Winnecke; all experienced astronomers except M. Paschen, appointed for his knowledge of photography. Afterward the commission invited to join in its deliberations Dove of Berlin, on account of his knowledge of meteorology, Prof. Zöllner of Leipsic for his knowledge of spectroscopic observations, and Otto Struve, Director of the Pulkowa Observatory. The early action of the German government and its wisdom in putting the matter into the hands of experienced astronomers are much to be commended. We may not be able and may not wish to follow the methods proposed by the German astronomers, but we must have prompt, deliberate, and concerted action, if we would obtain good results.

2. *On a Meteor seen at Konisha, Minn.;* by Thos. M. Young. (From a letter to Prof. Henry, Secretary of the Smithsonian Institution, and communicated by him).—I have the honor to report that a meteor exploded over this place at 2·20 P. M. on Saturday, February 4, 1871.

The aërolite seemed to come from the north of east, and when it reached a point about four degrees north of west of this place, lat. 45° 10 long. 94° 10′, and at an elevation of about 38°, it exploded with a detonation like the combined roar of a park of artillery; the concussion was so great as to shake houses. I have heard from four different points on a base line, 42 miles long, and observers at these points were not able to notice any divergence from the general direction of N. 86° W., consequently the distance must have been great to the point at which the aërolite exploded.

3. *Fall of Meteoric Stones at Concord, Ohio.*—Accounts of the fall of fragments of a meteorite in Guernsey Co., Ohio, are published

in volume xxxi, at page 87, 1861. The following is an additional notice of the same fall, from the Zanesville Courier of May 5, 1860, communicated for this Journal by Prof. HENRY.

An extraordinary phenomenon occurred on Tuesday, May 1, about noon, which has been noticed in many counties in Eastern Ohio. This occurrence, although it may be incredible to some, was certainly noticed by many in different localities about the same time. In this city the explosion, or noise, was distinctly heard. At New Concord, 16 miles east, a gentleman, who was out in his field, heard a loud crash, similar to sharp thunder; a succession of such crashes lasted for about half a minute and then died away, like the sound of a receding train of cars. On looking up, he observed an object descending with great rapidity, and on marking the point where it touched the earth, he there found a stone imbedded two feet in the earth, and somewhat warm, weighing 52 lbs. Another was found of 56 lbs., one of 40 and one of 36 lbs. in weight, all within the circumference of a few miles.

## IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Recent Auroral displays in the United States.*—In vol. 50, p. 146, (July, 1870), we have given the dates upon which Auroras were reported, by at least one of the observers of the Smithsonian Institution for the year 1869, and for three months of the year 1870. We now continue these observations to the close of the past year.

| 1870. | | |
|---|---|---|
| April | 1, 2, 3, 5, 6, 7, 8, 12, 15, 16, 18, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30. | Total, 21 days. |
| May | 1, 2, 3, 6, 7, 9, 13, 14, 15, 17, 18, 19, 20, 22, 24, 25, 26, 27, 28, 29, 30, 31. | " 22 " |
| June | 3, 6, 14, 15, 16, 17, 18, 19, 20, 23, 24, 26, 27, 30. | " 14 " |
| July | 1, 2, 3, 5, 6, 10, 13, 14, 15, 16, 18, 19, 23, 24, 25. 27, 28, 29, 30, 31. | " 20 " |
| Aug. | 2, 4, 7, 12, 13, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31. | " 19 " |
| Sept. | 3, 4, 6, 7, 8, 11, 12, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30. | " 21 " |
| Oct. | 1, 3, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31. | " 21 " |
| Nov. | 3, 8, 9, 12, 13, 14, 16, 17, 18, 19, 21, 22, 23, 24, 27, 28, 29, 30. | " 18 " |
| Dec. | 1, 4, 6, 8, 10, 14, 15, 16, 17, 19, 20, 21, 24, 27, 28, 29, 30. | " 17 " |

The following is a summary of the Smithsonian observations for the past two years.

| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1869 | 13 | 12 | 18 | 23 | 14 | 17 | 18 | 15 | 22 | 17 | 9 | 13 | 192 |
| 1870 | 19 | 18 | 23 | 21 | 22 | 14 | 20 | 19 | 21 | 21 | 18 | 17 | 233 |

These observations show a remarkable prevalence of auroras during these two years, and it is anticipated that the number will soon begin gradually to diminish. E. L.

2. *On the Color of the Lake of Geneva and the Mediterranean Sea.*—Mr. Tyndall's experiments with bottles of water from the Lake of Geneva and the Mediterranean sea placed in the convergent beam of an electric lamp seem to prove that the deep blue color is due to the effect of minute foreign particles suspended in the water, intercepting and scattering in excess the shorter waves of light. The path of the beam through the liquid was marked by a blue band.

From the blueness of the light transmitted through a column of the water, he concludes that part of the color must be due to a true molecular absorption of the less refrangible elements accompanying the blue.

These results accord with those of M. Soret, and with Mr. Tyndall's investigations into the causes of the blueness of the sky. He suggests that the fine particles suspended in the water of Lake Geneva, at least, are probably from glacial streams.

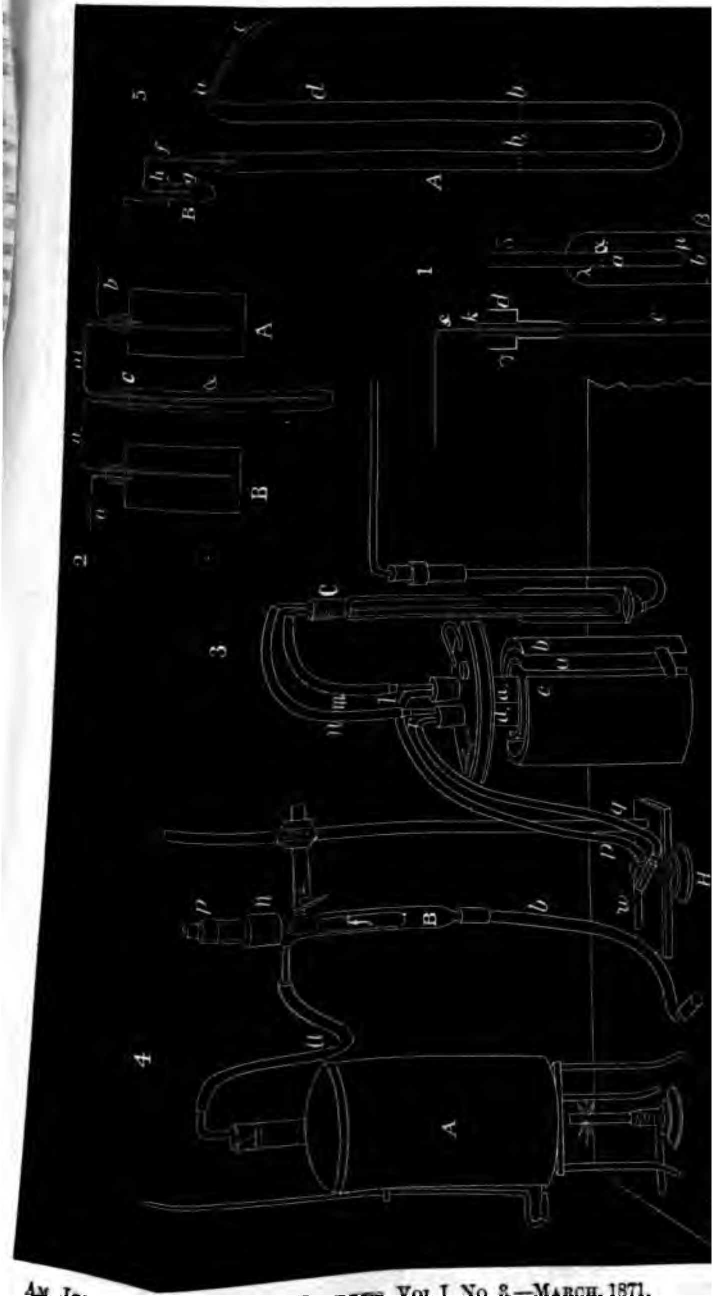
3. *A new Manual of Logarithms to seven places of decimals*; edited by Dr. Bruhns, Director of the Observatory, and Professor of Astronomy at Leipzig. 8vo. B. Tauchnitz, Leipzig, 1870; (D. Van Nostrand, N. Y.)—The arrangement of these tables is in many respects similar to that of Bremiker's excellent edition of Vega's seven-figure logarithms. The type is larger and clearer than that of Bremiker, being of the same Old English form. We agree with the editor in preferring it to the Egyptian type of Schrön, the only serious objection which we should urge to it being the liability to call 6 or 9 by mistake a zero. For the first six degrees of the octant the sines, cosines, tangents and cotangents are given to every second, whereas in Bremiker only sines and tangents are given, and that only for five degrees. For the remaining 39 degrees they are given to every 10 seconds. Wherever space allows, the proportional parts of differences are inserted in the margins of the parts. The arrangement of the pages in these 39 degrees is like that of Bremiker except in putting sines and cosines in *adjoining* columns. The arrangement for the first six degrees is quite different from and is better than that of Bremiker. Extraordinary care, it is claimed, has been taken to secure accuracy in printing, and the logarithms of the circular functions were independently computed, as well as compared with established tables. H. A. N.

4. *Valuation Tables on the "Combined Experience" or "Actuaries" Rate of Mortality;* by Elizur Wright. Second edition, revised and enlarged. Folios, xi, and 203 pp. Boston, 1871.—In the practical application of the principles of Life Insurance this country is believed to be in advance of Europe, and for this we are not a little indebted, directly and indirectly, to the State valuation of policies first carried into effect in Massachusetts by Prof. Wright as State Commissioner. These tables are at 3 and 4 per cent interest. The latter are those used in the State valuation.

The few pages of introduction are only enough to make us wish that Prof. Wright would develop at length the mathematical theory of Life Insurance so far as it applies to the methods now employed by American companies. H. A. N.

5. "*The Pliocene Skull," Illustrated.* 8 pp. Washington, D. C. —Bret Harte's "Pliocene Skull," a humorous poetical version of the discovery of the fossil skull in Calaveras Co., California, identifying it as that of the "old Pike" (i. e., from Pike Co., Mo.), Joe Bowers, famous in gold hunters' song, has been very cleverly illustrated by Dr. E. M. Schaeffer, son of Prof. G. C. Schaeffer, of Washington. The sketches add much to the point and wit of the verses.

Charles Mayer Wetherill, Professor of Chemistry in Lehigh University, South Bethlehem, Pennsylvania, died suddenly of heart disease on the 5th of March, aged forty-seven years.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fastened on a heavy iron stand by means of a vice, whose surround tightly the lower part of the iron head-piece *d*.

The amount of heat which a body evolves in cooling fr given temperature to 0° C., is determined by dropping it the water in the vessel *a* and thereupon closing the vessel with a cork, to prevent any circulation of air. If the prol be the relative measurements of quantities of heat, as in determination of specific heats, then the standard of compa is directly afforded by the number of scale-divisions w the mercury thread has passed on its retreat. If the read are rendered in an absolute measure, as for instance, in gran melted ice, or in units of heat, as the unit in the following p (always that quantity of heat being understood which one gra water at 0° C. absorbs in order to raise its temperature to 1° then it is only necessary to multiply the readings on the s with a constant which results from the following considerati

A mercury thread measured in the scale tube, which has temperature $t°$ and occupies T divisions of the tube after b corrected by the calibration table, weighs $g$ grams. Let fur the specific gravity of mercury at 0° C. be $S_q$, its coefficien expansion $\alpha$, then is the volume $v$ of a corrected division on scale, measured in cubic centimeters,

$$v = \frac{g\,(1+\alpha t)}{S_q T}.$$

For the instrument which I used, the values were:

$g = 0{\cdot}5326$ $\alpha = 0{\cdot}0001815$ $t = 9°$ C.

$S_q = 13{\cdot}596$ $T = 507{\cdot}4$

and therefore

$$v = 0{\cdot}00007733 \text{ c.c.} \quad - - - - - - - - - \quad (1)$$

If the specific gravity of ice at 0° C. be denoted by $S_e$, the cific gravity of water at the same temperature by $S_w$, the we of melted ice expressed in grams, which corresponds to volume $v$, that is, to one scale division with $p$, then is

$$\frac{1}{\frac{1}{S_e} - \frac{1}{S_w}} = \frac{p}{v}$$

or

$$\frac{v\,S_w\,S_e}{S_w - S_e} = p \quad - - - - - - - - \quad (2)$$

With regard to the specific gravity of ice we have many ob vations. The following comparison shows how little they a among themselves. For $S_e$

| | | | |
|---|---|---|---|
| Thomson found | 0·920 | Plücker and Geissler, | 0·920 |
| Heinrich, | 0·905 | | |
| Osan, | 0·927 | Kopp, | 0·908 |
| Royer and Dumas, | 0·950 | Dufour, | 0·922 (m |
| Brunner, | 0·918 | Dufour, | 0·914 (n |

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surround tightly the lower part of the iron head-pie

The amount of heat which a body evolves in coo
given temperature to 0° C., is determined by drop
the water in the vessel $a$ and thereupon closing the
with a cork, to prevent any circulation of air. If t
be the relative measurements of quantities of hea
determination of specific heats, then the standard of
is directly afforded by the number of scale-divis
the mercury thread has passed on its retreat. If t
are rendered in an absolute measure, as for instance,
melted ice, or in units of heat, as the unit in the follo
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THE

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[THIRD SERIES.]

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## ART. XLVI.—*On the Solar Corona;* by Prof. C. A. YOUNG, of Dartmouth College.

ALTHOUGH we have not yet official reports from the different parties who observed the solar eclipse of last December, it is perhaps not necessary to wait for them in order to form an idea of the state in which the problem of the sun's corona now stands.

From what has already appeared in the scientific and news journals, it is clear that while little new matter has been added to the stock of scientific knowledge, and while some questions are left in a more puzzling condition than ever, yet certain of the conclusions arrived at in 1869, but received with a good deal of reserve in certain quarters, have been fully confirmed and placed beyond further reasonable doubt.

The polariscopic observations are less accordant and conclusive than might be wished; undoubtedly because at all the stations they were more or less interfered with and complicated by the presence of clouds or haze.

On the whole, however, they seem to show pretty definitely that a portion of the coronal light is polarized in radial planes, and is therefore derived, not self-originated—almost certainly simple reflected sunlight—though, of course, the polariscope does not inform us whether the reflecting particles are near the sun, or the moon, or in our own atmosphere.

Very perplexing also is the fact that the faint continuous spectrum, which must be in part produced by this polarized component of the corona's light, shows no discoverable traces of the dark lines of the ordinary sunlight-spectrum. Probably they exist but are in some way masked so that they are not easily detected.

But if we grant that the polariscope has demonstrated the derivative character of one fraction of the coronal radiance, it is far more certain that the spectroscope has proved some of the matter of the corona, if not all, to be self-luminous; for its spectrum is characterized by a *bright line*. This line both in 1869 and 1870 was identified with a bright line of the chromosphere-spectrum which coincides exactly with a dark Fraunhofer line at 1474 of Kirchhoff's scale—(wave length 5316 according to Angström). Perhaps I may be allowed to step a little out of my way to add, that while it is customary to speak of this line simply as "a bright line near E," as if its exact position were somewhat doubtful, there is no occasion for the slightest reserve in the matter. The coincidence of the bright C line of the protuberance-spectrum with the dark C is no more accurately ascertained.

In the eclipse of last December, just before the beginning of the totality, the cross wires of my spectroscope were set carefully upon this line, already plainly bright in the spectrum of the chromosphere; and as soon as the sun was covered, I traced it out into the corona more than 16′ from the sun's limb. With the full dispersive power of 13 prisms, I have never been able to find the least want of correspondence between this line as seen in the chromosphere and its dark analogue, except occasionally such as was evidently due to the motion of the luminous matter, producing slight changes of refrangibility, sometimes in one direction and sometimes in the other.

So far as I can learn, this line was verified last December by all the spectroscopic observers who saw anything at all, with the single exception of Lieut. Brown of Lord Lindsay's party.

Two other faint lines which I saw in 1869 between this and D, and doubtfully* reported as corona-lines (see this Journal for Nov. 1869, p. 376), were not seen by any one on this occasion, unless perhaps one of them by Father Denza in Sicily.

In a letter from Father Secchi which appeared in the Astronomische Nachrichten for Feb. 21, 1871, he writes, "*Mon collegue le P. P. Denza directeur de l'observatoire de Moncalieri, observa avec un spectroscope, que j'avais convenablement disposé,* deux *raies brillantes dans le couronne, une prés de l'E de* Fraunhofer, *l'autre au milieu entre le vert et le jaune.*" Very possibly this latter ray "half way between the yellow and the green" may be one of the two.

Considered as a demonstration of self-luminosity, however, *one* bright line is just as conclusive as many.

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* I have experienced some annoyance during the past year at seeing these lines in several publications put upon the same footing as 1474. I was never at all confident as to their coronal character.

Nor can there be any doubt as to the location of the self-luminous matter. It cannot be in our own atmosphere, for no possible reason can be assigned why the particular molecules of air, that happen to lie near the lines which join the eye of the observer with the edge of the moon, should become luminous rather than others in a different portion of the sky.

Nor can it be at the moon; otherwise of course it would always be visible around her disc, since there is nothing in the mere accident of her being on the line of syzygies which could account for the phenomenon. I may add in passing, that I have often and carefully examined the neighborhood of the moon's limb, half hoping that some possible rare atmosphere of our satellite might reveal itself at some time by a faint auroral spectrum; thus far, however, without success.

Accordingly it is now universally, I think I may say, acknowledged that *one important element of the corona consists in a solar envelope of glowing gas, reaching to a considerable elevation.* Mr. Lockyer, who is still disposed to assign to the solar element of the corona a lower relative importance than most other astromomers, concedes a thickness of from *six* to *ten* minutes. (See an article by him in Nature for Feb. 23d.)

For this envelope the name of "*leucosphere*" has been proposed by a member of the Royal Astronomical Society at one of its recent meetings, and it seems to be a very suitable term and well worthy of adoption. It has been objected to on the ground that "*chromosphere*" covers the whole bright-line region around the sun; but when the latter name was first proposed, there was evidently no idea that above the envelope of hydrogen there lay another from 20 to 100 times as extensive, and it would certainly be very convenient to restrict it to the lower red hydrogen stratum of the solar atmosphere, and retain the new term to designate this more elevated mass of gaseous matter.

How extensive then is this leucosphere? Perhaps the question can hardly be answered definitely as yet; but it seems likely that it will be found to be at least from 8′ to 10′ thick on the average, with occasional prolongations of double that extent; not impossibly it may turn out to have no upper limit whatever, but to extend outward indefinitely into space.

Were it not for the interference of our atmosphere, the matter could be settled very summarily, at least as to a minor limit, by the record of the spectroscopic observations. Prof. Winlock observed the green line at a distance of more than 20′ from the sun, and others nearly as far. But there can be no doubt that had the spectroscope, during the eclipse, been directed upon any reflecting surface illuminated by the corona light, the same green line would have appeared in its spectrum. The question, of course, at once arises, whether the presence of this line at such a distance from the sun was not due to atmospheric reflection, especially as the sky was full of haze and light cirrus clouds at all, or nearly all, the stations of observation.

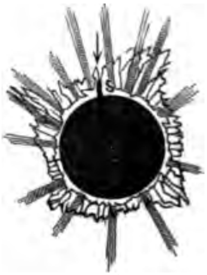
It is certainly difficult to say that such might not have been the case to some extent, for the hydrogen lines were seen at an elevation of 4′ to 5′, far above any possible hydrogen, and faintly even on the disc of the moon itself—evidently by just such an atmospheric reflection.

There is, however, an important difference between the behavior of the hydrogen lines, and that of 1474. At the edge of the chromosphere there was a sudden and very great falling off in the brightness of the former, while no such boundary was observed for the latter; the line grew regularly and continuously more faint as the distance from the sun increased, until it simply faded out, no abrupt alteration of its brilliancy being anywhere noticed. (I now speak of my own observations; but so far as I have learned, the experience of others was the same.)

In 1869 the difference between the hydrogen lines and 1474 was still more marked. The former could hardly be traced at all beyond the actual limit of the chromosphere, the air being so clear that there was very little atmospheric effect.

But there is another way of approaching the subject. The spectroscopes used by our party at Jerez were of two different classes, and by a combination of their results we may obtain an indication of considerable value.

In the instruments employed by Prof. Winlock and myself, and I presume by the greater number of the eclipse observers, the spectroscope is attached to the eye-end of a telescope whose object-glass throws upon the slit a distinct image of the body to be examined. Such an instrument may be called an *analyzing* spectroscope, since it deals with elementary portions of the luminous area under investigation. Thus, if the figure represent the image of the corona, chromosphere and moon formed by the object-glass of the telescope, then if the slit be placed as at S, the spectrum seen will be produced solely by light from those elements of the luminous area whose foci fall within its jaws. The spectrum will be divided longitudinally into two portions, of which the one derived from the upper portion of S will show only the lines due to the leucosphere, while the other will exhibit the chromosphere lines *plus* those of the leucosphere.



(Of course it must be remembered that while the hydrogen does not extend above the limit of the chromosphere, the coronal matter does reach down to the surface of the sun, and in the chromosphere is mingled with the hydrogen; indeed, except during eclipses, it is only at the very base of the chromosphere that the 1474 line can be seen reversed with our present spectroscopes.)

If now we assume the chromosphere and leucosphere each to be of uniform brightness throughout (a supposition not strictly true but allowable for our present purpose), then by putting $a$ for the angular area of the chromosphere, $x$ for that of the leucosphere, $i$ for the intensity of the bright 1474 line as seen in an "analyzing" spectroscope, and $ni$ for the intensity of the bright C line observed with the same instrument, we shall have

$$i\,x=[1474],$$

where [1474] represents the total quantity of "1474 light" coming from the whole leucosphere. Similarly

$n.\,i.\,a.=[C]$, where [C] represents in the same manner the total "C light" from the chromosphere.

$$\text{Hence} \quad x=n.\,a.\,\frac{[1474]}{[C]}$$

Now, as nearly as I can estimate, the ratio between the brightness of the C and 1474 lines is about the same as that between a star of the first magnitude and one of the fifth or sixth. That is to say, the C line is between twenty-five and one hundred times as bright as 1474; so that in our equations we may write $n=50$ as a fair approximation, and we shall have

$$x=50\,a\,\frac{[1474]}{[C]}$$

In order to find $x$ in terms of $a$ it only remains to find the ratio of [1474] to [C]. For this purpose we must employ a spectroscope so arranged that its slit may receive at every point, light coming indiscriminately from every part of the object. This is the case when a spectroscope is used, unconnected with any telescope, by simply pointing the slit of its collimator toward the source of light. Thus used it may be called an *integrating* instrument, since it sums up in each bright line of its spectrum, the whole quantity of each kind of light reaching the slit from the whole luminous area included within its field.

An instrument of this sort was employed by Prof. Pickering in 1869, and with results of considerable importance.

Accordingly, two of the gentlemen of our party were equipped in the same manner, and one of them, Mr. Pye, by my request, noted the brightness of the lines on an arbitrary scale from ten down, with the following result: [C] 8·5, [$D^3$] 5·5, [1474] 10, and [F] 3. Probably the squares of these numbers would more nearly express the true ratio of the intensities, since we seem instinctively to estimate one light as twice the intensity of another when it appears of the same brightness at a double distance, and so on.

If so, we have $\frac{[1474]}{[C]} = \left(\frac{10}{8\cdot5}\right)^2 = \frac{100}{72}$ nearly; and recurring to our last written equation we get $x = 69\cdot4\,a$.

Similarly, from $D_3$, $(n=20)$, I find $x = 64\cdot5a$; and from F, $(n=10)$ $x = 111\cdot1a$.

The last value is evidently too large, the discrepancy probably arising from the fact that Mr. Pye's instrument having a prism of the extra dense and very yellow flint-glass considerably reduced the intensity of the F line by absorption.

Thus far, we have neglected the inequalities of shading and illumination; but as both chromosphere and leucosphere decrease in brilliancy pretty regularly from the limb of the sun, and since the upper limit of the former is much the more definite, it is evident that the introduction of these considerations would increase the computed ratio. We may, I think, then safely assume that the angular area of the leucosphere is *at least* 70 times as great as the area of that portion of the chromosphere and prominences which was exposed to view during the totality. I fear it is not possible to estimate this area with much certainty, but think it could hardly have been equivalent to anything less than a ring of 9″ or 10″ wide surrounding the sun. If so, we find the leucosphere to be equivalent to a ring of about 10′ in width, and considering the irregularity of its outline, some of the angular prolongations would be likely to attain twice that distance.

I am, of course, aware that the numerical data of this calculation are very uncertain, being mere estimates, not measurements; but the principle is correct, and the results are not sensibly affected by any ordinary amount of atmospheric influence, since the different colored rays would not have the *ratio* of their brilliancies much disturbed under any reasonably fair conditions.

The result agrees very well also with the photographs, drawings, and estimates of skilled observers.

As for the *long rays*, both bright and dark, which are often, and perhaps usually, seen crossing the leucosphere and reaching far beyond, the question whether they are also solar appendages appears to be very different and far more doubtful.

In the first place, I doubt if they are *always* present. At any rate, in 1869, in a most exceptionally clear atmosphere, I saw nothing of them at Burlington, Iowa, and believe (but am not absolutely certain) that none of our party did; while some observers in Kentucky saw them well, and at Sioux City they were especially conspicuous, as is evident from the remarkable, and I have no doubt, accurate picture given by Mr. Gilman in the Eclipse Report of the Naval Observatory.

In December, so far as I have heard, every one saw them. I have no hesitation in affirming that the corona as it appeared to me then was a very different phenomenon from what I saw the year before, and far more complex.[*]

The photographs also taken by Lord Lindsay's and the American parties in Spain, appear to differ essentially from each other, and from those taken by Mr. Brothers, in Sicily; and that in such a way as to suggest at least, that this more extensive radiance is of a far less permanent character than the leucosphere, and possibly of a different origin.

Should it turn out to be visible only where the sky is hazy, it might then be regarded as an effect of our own atmosphere produced, of course, not by the ordinary photospheric sunlight (which, as has been abundantly shown, by many writers, cannot during totality, illuminate the air near the moon's place), but by the light from the prominences and the lower regions of the leucosphere.

If, on the contrary, as seems to be the case, this radiance is often seen under unexceptionable atmospheric conditions, we appear to be shut up to one of two theories; either on the one hand that of Prof. Norton and Mr. Proctor, whose views regarding these rays are nearly identical, and represent them to be streams of matter, similar to cometary substance or auroral[†] beams, driven off by some solar repulsion; or on the other hand that of Oudemans, who considers them to be purely optical effects produced in cosmical dust between us and the moon, by the sunlight streaming across the uneven and ragged edge of our satellite.

With reference to the former theory, it is probably sufficient to refer to Mr. Proctor's recent work on the sun, and to a paper which Professor Norton has published in a late number of this Journal, wherein his views are fully explained. According to this view, the leucosphere and the rays are alike solar appendages, and of identical origin and material.

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[*] Mr. Lockyer, in "Nature" for Feb. 23d, quotes from a letter of mine written a year ago, to show that my opinions regarding the nature of the corona have been considerably modified since then; and this is true to some extent, though I think the present approximation of our views is owing quite as much to a change in his own ideas—as would be evident on referring to his papers of the same, and even somewhat later date. But I should *still* write "I am strongly disposed to believe that the whole phenomenon" (*i. e., the Corona as I saw it in* 1869) "is purely solar."

[†] Since my name has sometimes been referred to in connection with the so-called "Auroral Theory of the Corona," it is proper for me to state, that I make no claim to be its originator.

When I discovered (as I supposed), the identity of the bright line in the corona spectrum with a line in that of the aurora, and announced my belief in the substantial identity of the two phenomena, I considered myself as simply subscribing to a view already current, and bringing a new argument to its support.

So far as I know, Prof. Norton was the first to work out and publish a connected theory of the subject, basing his conclusions largely upon his discussions of Donati's comet, which were printed in this Journal some years ago. Prof. Winlock also informs me that he has held and published a very similar opinion, and so I think have more than one of the European astronomers, though I cannot now give references. My own father, more than twenty years ago, was accustomed to teach from the same chair of astronomy which I now occupy, an essentially similar doctrine. Thus the idea had long been familiar to me, and I presume more or less so to astronomers generally.

The theory of Oudemans is stated in a letter to "Nature," contained in the number for Nov. 10, 1870.

With good weather, it would seem possible to decide between these two hypotheses at the next eclipse.

A series of corona photographs taken as rapidly as possible on the plan pursued by Mr. Brothers (who has shown that an exposure of from 8 to 10 seconds is sufficient to produce a fine picture) would probably indicate whether the dark streaks are really related to mountains on the edge of the moon or not.

It is probable also, as Prof. Pickering has suggested, that important information may be obtained by observing them with a spectroscope of high dispersive power and widely opened slit, using the 1474 line just as the C line is used in examining the prominences.

The telescope, to which the spectroscope employed for the purpose is attached, should be of wide angular aperture, so as to give abundant light, but of very short focus, forming an image of the sun not much more than ¼ of an inch in diameter, in order that the rays may be so little magnified that their outline, if they are really of leucospheric origin and give the green monochromatic light, may be readily observed through the slit.

There remains still unsettled another interesting series of questions concerning the nature of the substance composing the leucosphere, and the relation of this envelope to the sun; whether it be a true atmosphere, or a mere cloud of transient particles—a meteor-flock, as Mr. Proctor imagines.

Apart from the difficulty of supposing such a multitudinous and continual supply of meteoric matter as this theory would require, and neglecting all consideration of the peculiar form assumed by this envelope, which seems to be deepest precisely over those solar latitudes where the spots and prominences are most numerous, and even to be governed in the minutiæ of its outline by the position of its prominences, I find what seems to me an almost insuperable objection to it in the powerful winds and cyclones which prevail in the region above the chromosphere at elevations of from 50,000 to 100,000 miles.

These winds, by which the tops of the solar flames are whirled and driven, present, so far as observations now go, every characteristic of true aerial currents in a continuous medium; and the whole appearance and behavior of the solar protuberances, except at the moment of eruption, is that of clouds floating in an air.

But if we then consider the leucosphere as a true solar atmosphere, how can we reconcile its enormous extent with the known smallness of the pressure at its base, determined by the experiments of Lockyer, Frankland, and Wullner? In either of two ways; first, and perhaps on the whole most probably, this atmosphere may consist of some new kind of matter whose density is far below that of even hydrogen; or it may be composed of matter whose specific *gravity* (*not density*) is diminished, annihilated, or even rendered negative by some such solar repulsion as appears to be operative in the formation of a comet's tail.

There is no doubt that the line which characterizes its spectrum coincides with one of the lines of the *Iron* spectrum within the limits of any present means of observation: and so close a coincidence can hardly be accidental. And yet in the spectrum of iron, this line is only a faint and unimportant one—one of the last to make its appearance under the stimulus of the electric spark, and so little comparable in intensity with many others in its immediate neighborhood, that Mr. Huggins failed to map it on his spectral chart.

It is certainly difficult to understand how, if this line be really of the same origin as its fellows, it should remain the sole survivor of changes which have been able to exterminate from the spectrum all its more conspicuous associates; and accordingly, from this point of view, it becomes natural to suppose, as I suggested in 1869, that when the line appears in the spectrum of iron it may be due not to the iron itself, but to some associated substance (possibly standing in relation to the peculiar magnetic properties of this remarkable metal)—some occluded gas, which can also exist free in a state of inconceivable tenuity, as we have it in the leucosphere, and probably also in the streamers of the aurora, and in the tails of comets*—a near relative, so far as gravity is concerned, to the luminiferous ether and to the Urstoff of German speculators.

The view of Mr. Lockyer agrees with this in supposing the leucosphere to consist of some new form of matter.

On the other hand, it is to be noted that alterations of pressure and temperature do produce in known spectra great changes, somewhat such as would be required in order to reduce the complicated spectrum of iron to this one line. (But I do not know of any case where one of the unimportant lines is the last to disappear.)

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* It is perhaps worthy of remark that in the spectrum of Brorsen's comet, as given by Mr. Huggins, the position of one of its three bands appears to coincide with 1474, so far as can be judged from the figure and the measurements, which, however, do not permit any very rigid testing of the matter. It seems somewhat probable that this same line will be observed in the spectrum of the tail of the first bright comet offered to observation.

Furthermore, those other lines of iron, which are often seen in the chromosphere spectrum, are nearly all of about the same order of prominence as 1474. The more conspicuous iron lines seldom if ever appear reversed, while in the case of other substances their strongest spectral lines are always the first to turn bright.

If then we admit a sufficient repulsive force, it seems still possible to suppose that the leucosphere may consist of iron in the state of vapor and fog; and the well known wide diffusion of this metal in meteoric matter makes it comprehensible how its lines should occur in the spectrum of our own terrestrial aurora, and in any other places where they may be found.

Possibly future researches in the laboratory may throw clearer light upon the subject.

It is hardly necessary to add that our own terrestrial atmosphere, *when clear*, appears to me to play only a very subordinate part in the phenomenon. Some influence it must, of course, have; but remembering how much the inner portion of the coronal ring exceeds in brilliance the outer, it would seem that the illumination of the lunar disc must give us an exaggerated measure of the true atmospheric effect. This illumination makes the edge of the moon only enough brighter than the center to give it the appearance of a globe, but of almost inky blackness.

With the subjective element, the case is very different. In untrained observers especially, it may be so influential that two intelligent persons standing side by side will describe and even sketch upon paper appearances most grotesquely different from each other and from the truth.

Even skilled observers are greatly affected by the strangeness and peculiar nature of the phenomenon, and the excitement of the occasion.

Hanover, March 23d, 1871.

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## ART. XLVII.—*On the supposed Legs of the Trilobite, Asaphus platycephalus;* by JAMES D. DANA.

AT the request of Mr. E. Billings of Montreal, I have recently examined the specimen of *Asaphus platycephalus* belonging to the Canadian Geological Museum, which has been supposed to show remains of legs. Mr. Billings, while he has suspected the organs to be legs so far as to publish on the subject,* has done so with reserve, saying, in his paper, "that the first and all-important point to be decided, is whether or not the forms exhibited on its under side, were truly what they appeared to be, locomotive organs." On account of his doubts, the specimen was submitted by him during the past year to the Geological Society of London; and for the same reason, notwithstanding the corroboration there received, he offered to place the specimen in my hands for examination and report.

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* Q. J. Geol. Soc., No. 104, p. 479, 1870, with a plate giving a full-sized view of the under surface of the trilobite, a species that was over four inches in length.

Besides giving the specimen an examination myself, I have submitted it also to Mr. A. E. Verrill, Prof. of Zoology in Yale College, who is well versed in the invertebrates, and to Mr. S. I. Smith, assistant in the same department, and excellent in crustaceology and entomology. We have separately and together considered the character of the specimen, and while we have reached the same conclusion, we are to be regarded as independent judges. Our opinion has been submitted to Mr. Billings, and by his request it is here published.

The conclusion to which we have come is that the organs are not legs, but the semi-calcified arches in the membrane of the ventral surface to which the foliaceous appendages, or legs, were attached. Just such arches exist in the ventral surface of the abdomen of the Macrura, and to them the abdominal appendages are articulated.

This conclusion is sustained by the observation that in one part of the venter three consecutive parallel arches are distinctly connected by the intervening outer membrane of the venter, showing that the arches were plainly *in the membrane*, as only a calcified portion of it, and were not members moving free above it. This being the fact, it seems to set at rest the question as to the legs. We would add, however, that there is good reason for believing the supposed legs to have been such arches in their continuing of nearly uniform width almost or quite to the lateral margin of the animal; and in the additional fact, that, although curving forward in their course toward the margin, the successive arches are about equidistant or parallel, a regularity of position not to be looked for in free-moving legs. The curve in these arches, although it implies a forward ventral extension on either side of the leg-bearing segments of the body, does not appear to afford any good reason for doubting the above conclusion. It is probable that the two prominences on each arch nearest the median line of the body, which are rather marked, were points of muscular attachment for the foliaceous appendage it supported.

With the exception of these arches, the under surface of the venter must have been delicately membranous, like that of the abdomen of a lobster or other macruran. Unless the under surface were in the main fleshy, trilobites could not have rolled into a ball; and the fact that this particular species of Asaphus is not found so rolled may be owing to the unusual size or firmness, and also the position, of these slender arches.

## ART. XLVIII.—*Description of some new Fossil Serpents, from the Tertiary Deposits of Wyoming;* by Professor O. C. MARSH, of Yale College.

AMONG the Reptilian fossils discovered by the Yale College party, during their explorations last summer in the Green River Tertiary basin, west of the Rocky Mountains, were the remains of several species of Serpents, which are of peculiar interest, as they are the first extinct Ophidians found in the interior of the continent, and, with the exception of three species from the Eocene marl of New Jersey,* the only fossil representatives of this order yet detected in this country.

These remains, which are now in the Peabody Museum of Yale College, consist mainly of vertebræ, of various sizes, many of them more or less injured, but in general with the most characteristic parts well preserved. Nearly all the specimens obtained evidently belonged to constricting serpents, closely related to the modern Boas of South America, although considerably smaller, and generically distinct. A few of the specimens indicate snakes of moderate size, with apparently quite different affinities.

In comparing the larger series of these fossil vertebræ, especially those from near the middle of the trunk, with the corresponding vertebræ of the living species of *Boa*, a strong resemblance will be noticed in the more important characters, especially in the transversely elliptical outline of the articular cup and ball; in the obtuse lateral elevation extending from the diapophyses to the articular ball; and in the elongated median ridge on the inferior surface of the centrum. The differences between them, however, are important, and indicate clearly that the fossil specimens represent a separate genus, for which the name *Boavus* † is proposed, in allusion to the not improbable relationship of the two types. In the extinct genus, the articular ball and cup are more nearly vertical, and their outline forms a more full transverse ellipse. The neural arch is proportionally more elevated, and has on either side a low ridge, extending backward from the articular face of the zygosphene, and expanding over the zygantral cavities. The latter are more deeply excavated than in *Boa*. The neural spine is shorter, its antero-posterior extent, in the specimens in which it is preserved, being greater than its height. The diapophyses are convex throughout, while those of *Boa* are more or less concave on the lower part of their articular face. The lateral elevation, extending from the diapophyses to the articular ball, is, in *Boavus*, situated lower on the centrum, and is less rounded. The hypapophysial ridge, also, is sharper, and extends nearer to the inferior edge of the articular ball.

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* This Journal, vol. xlviii, p. 397, Nov. 1869.

† *Boa*, and *avus*, grandfather.

From the vertebræ of *Dinophis* Marsh, which genus includes the only fossil Ophidians hitherto found in this country, as well as from those of the nearly allied *Palæophis* of Owen, the specimens of *Boavus* here described are widely separated, especially by their greatly inferior size; by the shorter neural spine; by the broader zygosphene, which exceeds in transverse diameter the articular cup, as in most modern serpents; by the elevation extending backward from the zygosphene; by the more expanded diapophyses; and by the well developed lateral and inferior median ridges on the centrum. The vertebræ of *Boavus*, however, resemble those of *Palæophis* and *Dinophis*, and differ from those of *Boa*, *Crotalus*, and many other modern serpents, in having the sides of the neural canal extended forward nearly to the edge of the articular cup.

### *Boavus occidentalis*, sp. nov.

This species is established on eight vertebræ, nearly all from the middle dorsal region. They evidently represent several individuals, as they differ considerably in size, and were found at three separate localities. They indicate constricting serpents between six and eight feet in length. The neural arch in this species is elevated and massive. The neural spine is short, and triangular at its base, which rests on the posterior three-fourths of the arch. The zygosphene is convex above, slightly excavated in front, and without a median tubercle. The neural canal has a distinct median epapophysis on its floor, and sharp lateral ridges, which give it a sub-trifoliate outline. The diapophyses are auriform, and project below the inferior margin of the cup. The hypapophysis is a sharp ridge, beginning at the margin of the cup, and ending, just before reaching the ball, in an obtuse projection.

The principal dimensions of one of the largest vertebræ of this species are as follows:—

| | | |
|---|---|---|
| Length of centrum from edge of cup to convexity of ball, | 4·50 | lines. |
| Transverse diameter of cup, | 2·80 | " |
| Vertical diameter of cup, | 2·50 | " |
| Transverse diameter of zygosphene at base, | 3·50 | " |
| Distance from top of zygosphene to lower margin of cup, | 5· | " |
| Vertical diameter of ball, | 2·45 | " |
| Width of neural canal in front, | 1·75 | " |
| Height of neural canal in front, | 1·10 | " |

The various specimens representing this species were found in September last by H. B. Sargent, A. H. Ewing, and the writer, at Grizzly Buttes, near Fort Bridger, Wyoming Territory. The geological horizon is probably Eocene.*

### *Boavus agilis*, sp. nov.

This species, which was nearly the same in length as the preceding, although apparently much more slender, is indicated by five vertebræ, all from the dorsal region, and representing two or more individuals. They may readily be distinguished from the corresponding vertebræ of *B. occidentalis*, by the proportionally more elongated centrum; by the rounder and more inclined cup; by the more expanded anterior zygapophyses; by the diapophyses, which do not extend below the inferior surface of the centrum; and by the hypapophysial ridge, which is more obtuse, and in its anterior portion expands rapidly until it disappears in the margin of the cup.

The largest vertebra of this series has the following dimensions:—

| | | |
|---|---|---|
| Length of centrum from edge of cup to convexity of ball, | 4·25 | lines. |
| Transverse diameter of cup, | 2·50 | " |
| Vertical diameter of cup, | 2·40 | " |
| Vertical diameter of ball, | 2·35 | " |
| Width of neural canal in front, | 1·75 | " |

The specimens on which this species is based were discovered by the writer, near Fort Bridger, in the same formation as the remains above described.

### *Boavus brevis*, sp. nov.

The serpents representing this species were considerably smaller than those described above, and evidently much shorter in proportion to their bulk, being probably not more than four or five feet in length. The only remains obtained consist of three dorsal vertebræ, all in good preservation, and evidently belonging to two different individuals. These vertebræ have the centrum unusually short, its extent measured on the inferior surface scarcely exceeding the transverse diameter of the zygosphene. The neural arch is low, and bears on its posterior two-thirds the neural spine, which is quite short, and truncated. The zygosphene is less massive than in the preceding species, and has a slight median swelling on the anterior margin of its base.

The dimensions of the most perfect of these vertebræ are as follows:—

| | | |
|---|---|---|
| Length of centrum from edge of cup to convexity of ball, | 2·20 | lines. |
| Transverse diameter of cup, | 1·60 | " |
| Vertical diameter of cup, | 1·25 | " |
| Transverse diameter of zygosphene at base, | 1·85 | " |
| Distance from top of zygosphene to lower margin of cup, | 2·80 | " |
| Width of neural canal in front, | 1·00 | " |
| Height of neural canal in front, | ·90 | " |

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* This Journal, III, vol. i, p. 192, March, 1871.

The specimens here described were found by H. B. Sargent, in the same fresh-water Tertiary deposits, and near the same locality, as the two preceding species.

### *Lithophis Sargenti*, gen. et sp. nov.

This species and genus are at present represented by three trunk vertebræ, only one of which, however, is sufficiently well preserved to show all its more important characters. The specimens indicate a small serpent about four feet in length, and probably, like the preceding species, allied to the constrictors. From the vertebræ of *Boavus*, as well as from those of the other fossil Ophidians discovered in this country, the present specimens may be readily distinguished by the more compressed centrum, and especially by the articular cup and ball, which are circular in transverse outline, as in the Arican *Eryx*, and stand nearly at right angles to the axis of the centrum. The anterior zygapophyses, also, are more extended outward, and their articular faces have a greater antero-posterior expansion than in any of the described species. The diapophyses have their articular surfaces divided by a horizontal groove, having a rounded tubercle above, and a pointed projection below, as in the modern *Bascanion*. There is no lateral ridge extending from the diapophyses to the articular ball, as in *Boa* and *Boavus*, the converging sides of the centrum being nearly flat. The hypapophysis is reduced to a wedge-shaped ridge, extending the whole length of the centrum, and having its sharp apex below the inferior margin of the cup. The floor of the neural canal has a prominent, obtuse median ridge throughout its whole length, but no lateral ridges are apparent.

The principal measurements of the best preserved vertebra are as follows:

| | | |
|---|---|---|
| Length of centrum from edge of cup to convexity of ball, | 2·80 | lines. |
| Transverse diameter of cup, | 1·35 | " |
| Vertical diameter of cup, | 1·35 | " |
| Vertical diameter of ball, | 1·30 | " |
| Width of neural canal in front, | ·90 | " |
| Distance from end of anterior zygapophysis to hypapophysis, | 3·00 | " |
| Distance between ends of the anterior zygapophyses, | 4·50 | " |

For the extinct genus manifestly indicated by the fossils here described, the name *Lithophis** is proposed, and the species they represent may appropriately be called *Lithophis Sargenti*, after the discoverer, Mr. H. B. Sargent, of the Yale Scientific party, who found the specimens in the Eocene "Mauvaises Terres" beds at Grizzly Buttes, near Fort Bridger.

* *Λίθος, stone, and Ὄφις, serpent.*

### *Limnophis crassus*, gen. et sp. nov.

One of the most interesting of the Ophidian fossils obtained during our explorations in Wyoming was a single anterior dorsal vertebra, very well preserved, and quite unlike any hitherto described. It indicates a moderately sized constricting serpent, perhaps six feet in length, but evidently of a very different type from the species already characterized. On comparing it with the corresponding vertebræ of *Boavus* and *Lithophis*, a striking difference is at once seen in the dimensions of the articular cup, which considerably exceeds in width the parallel diameter of the base of the zygosphene, a feature only observed heretofore in a few fossil serpents from the Eocene, and quite unknown in modern species. The cup and ball have a subtriangular, ovate outline, the greatest transverse diameter being above the center: they are also placed nearly at right angles to the axis of the centrum. Another marked peculiarity of this vertebra is the unusual posterior extension of the neurapophyses, which project some distance beyond the articular ball. Their nearly flat sides slope downward and outward like a gable roof, without any indication of the angle so characteristic of the vertebræ of Palæophis,* which in several other respects the present specimen strongly resembles. The neural spine is unfortunately not preserved, but it was evidently short, and confined to the posterior two-thirds of the neural arch. The anterior zygapophyses had only a moderate expansion. The diapophyses have, for the attachment of the rib, a single, rounded, and prominent tubercle, with its lower border above the inferior margin of the cup, and with no indication of a dependant process. There is also no ridge extending from the diapophysis to the articular ball. The hypapophysis consists of a single, compressed, obtuse tubercle, which descends from the middle of the centrum downward and slightly forward; its base occupying rather more than half of the median line.

The more important dimensions of this vertebra are as follows:

| | | |
|---|---|---|
| Length of centrum from edge of cup to convexity of ball, | 3·20 | lines. |
| Transverse diameter of cup, | 2·30 | " |
| Vertical diameter of cup, | 1·80 | " |
| Vertical diameter of ball, | 1·70 | " |
| Distance from posterior summit of neurapophyses to inferior margin of ball, | 3·50 | " |
| Length of hypapophsis below inferior margin of cup, | ·90 | " |

This interesting vertebra, although the only one of the kind at present known, is so characteristic, and well preserved, and differs so widely from the corresponding remains of Ophidians hitherto described, as to justify establishing for its reception a new genus, which may be called *Limnophis.** The species may properly be named *Limnophis crassus*, in reference to the probable proportions of the extinct serpent thus indicated. The specimen was discovered by Mr. A. H. Ewing, a member of the Yale party, in the Eocene fresh-water deposits, near Marsh's Fork, about fifteen miles from Fort Bridger, in Wyoming.

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* Memoirs of Paleontological Society of London, 1850, p 57.

Yale College, New Haven, March 20th, 1871.

## ART. XLIX.—*Contributions to Chemistry from the Laboratory of the Lawrence Scientific School. No. 14.—On the Estimation of Phosphoric Acid*; by CHARLES E. MUNROE.

§ 1. THOUGH the methods commonly in use for the quantitative determination of phosphoric acid are capable in most cases of giving accurate results, yet it will, I think, hardly be claimed for them, that they render new methods unnecessary, and I have therefore undertaken the following investigation in the hope of adding something of value to our analytical resources.

My attention was first called to the employment of ferric chloride with the addition of sufficient mercuric oxide to neutralize the excess of acid. Free mercuric oxide was first added directly, but, as a complete separation could not be effected in this manner, it was found more advantageous to produce the oxide in the solution itself. This was accomplished by first adding mercuric chloride and then potassic or sodic hydrate. As sodic hydrate† can be obtained in commerce absolutely pure this was employed. The precipitate, consisting of ferric phosphate and ferric and mercuric oxides was then evaporated to dryness in the manner recommended by Chatard,‡ filtered and washed on the Bunsen pump.§ Unhappily the phosphoric acid redissolved after evaporation to dryness and the process was therefore abandoned. Bunsen's delicate test with magnesium wire was used throughout the work, sometimes in connection with ammonic molybdate, for the detection of phosphoric acid.

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* Λίμνη, *lake*, and Ὄφις, *serpent*.

† The article used was manufactured in England by the direct oxidation of metallic sodium.

‡ This Journal, vol. iv, p. 247.

§ A simple modification of the Bunsen pump may be obtained by connecting a piece of glass tubing, by means of rubber, with a Bunsen funnel. A funnel holding 50 $c.m.^3$ connected with a piece of glass tubing one meter in length emptied itself five times while another funnel of the same capacity, arranged as usual, did so but once. The pressure was so great that the filter had to be protected with a platinum point to prevent it from giving way.

I next studied the behavior of aluminic oxide toward phosphoric acid, and this time met with better success.

The following course was pursued. To the boiling phosphate solution a weighed quantity of pure aluminic sulphate, previously dissolved, was added. A solution of mercuric chloride was then added, and finally sodic hydrate until a precipitate of mercuric oxide was obtained which remained undissolved. In order to hasten the operation the precipitate was allowed to settle and the supernatant liquid poured upon the filter. The gelatinous precipitate was then evaporated to complete dryness as before mentioned, filtered, ignited and weighed. The increase of weight, over that of the aluminic oxide used, was phosphoric oxide. It was found extremely difficult to burn the filter. Care must be taken that for every gram of phosphoric oxide at least two grams of aluminic oxide are added.

The percentage of aluminic oxide, in the sulphate used, was determined by ignition, ammonic carbonate being used to drive off the last traces of sulphuric oxide. The following results were obtained:

(1) ·7320 grms. $Al_2(SO_4)_3 . 18H_2O$ gave ·1310 grms. $Al_2O_3$ = 17·89 p. c.
(2) ·7100 " " " ·1270 " " = 17·87 "
Mean 17·88.

Anhydrous disodic phosphate was the first salt treated. In order to work with greater rapidity a solution of known strength was prepared of which 50 c.m., corresponded to ·6195 grms. of phosphate. This gave the following results:

(1) ·6195 grms. gave ·3099 grms. $P_2O_5$ = 50·02 p. c.
(2) ·6195 " " ·3100 " " = 50·03 "
(3) ·6195 " " ·3097 " " = 50·01 "
(4) ·6195 " " ·3097 " " = 50·01 "
Mean 50·02. Theory 50·00.

Ammonio-sodic phosphate $(Na(NH_4)H Po_4, 4H_2O)$ was next analyzed. The amount of phosphoric oxide in the salt was found by igniting it and weighing the sodic metaphosphate.

(1) 1·4650 grms. gave ·6172 grms. $NaPO_3$ = 29·32 p. c. $P_2O_5$
(2) 1·5017 " " ·6344 " " = 29·40 " "
Mean 29·36.

By the alumina process the following results were then obtained.

(1) 1·5405 grms. gave ·4514 grms. $P_2O_5$ = 29·30 p. c.
(2) 1·2610 " " ·3707 " " = 29·39 "
(3) 1·1355 " " ·3321 " " = 29·29 "
Mean 29·33.

Calcic phosphate did not give good results by this process on account of the difficulty of washing out the calcic sulphate formed. I succeeded no better with ammonio-magnesic phosphate doubtless because some of the magnesia went down with the alumina. These experiments are sufficient to show that phosphoric acid may be determined with extreme precision in the alkaline phosphates by the method above given, but the method applies with advantage only to these salts. On the other hand it must be remembered that many phosphates may be decomposed by fusion with the alkaline carbonates and the phosphoric acid then determined as above, so that in fact the method applies in perhaps the greater number of cases which occur in practice.

§ 2. Rose's* method for the separation of phosphoric acid by means of mercurous nitrate and subsequent estimation in the form of pyrophosphate of magnesia has been much used. It will, however, be acknowledged that it has some serious defects. It is tedious, the many operations required increase the chances of error, and the fusion of mercurous phosphate with the mixed carbonates exerts, according to Rose, a sensible action upon the platinum crucible. Nevertheless the perfect separation which it gives is a strong recommendation of the method.

It appeared possible that a valuable modification of this process might result from the addition of mercuric oxide in the manner already employed in the alumina process above described.

The experiments were executed in the following manner. To a boiling solution of the phosphate mercurous nitrate was added in slight excess. This threw down a lemon-yellow colored, crystalline precipitate of nitro-mercurous phosphate which adhered to the sides of the beaker when touched by the stirring rod. Mercuric nitrate was then added and finally sodic hydrate until a slight precipitate of mercuric oxide was obtained which remained undissolved. The mixture of the two salts was found to be insoluble in both hot and cold water, and to wash like sand.

The next step was to find a readier means of treating the nitro-mercurous phosphate.

It was first proposed to dissolve the washed and dried precipitate in chlorhydric acid and titrate with potassic permanganate so as to oxidize the mercurous to the mercuric salt. This process failed. The salt was then treated with sulphuric acid. The final reaction was perfectly sharp, but the results were not satisfactory.

These results having proved that nothing was to be gained in that direction, I tried to remove the mercury by decomposing the nitro-mercurous phosphate with nitric acid and precipitating the mercury with sulphydric acid or ammonic sulphide. The phosphoric acid was then to be determined in the filtrate by the ammonio-magnesian solution. On examining the mercurous sulphide it was found that some of the phosphoric acid was always precipitated with it. Its presence was proved by Bunsen's test with the magnesium wire. The salt was then dissolved in a solution of potassic cyanide and a current of sulphydric acid passed through, but with the same result as before. Again it was thought that the phosphoric acid might be precipitated directly from the cyanide solution by ammonio-magnesic chloride, but experiment showed that the cyanide contained so much cyanate and carbonate that, although the solution was boiled and chlorhydric acid was added to it, accurate results could not be obtained.

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* Traité de Chimie Analytique, ii, 708.

As the ignition of the nitro-mercurous phosphate with the non volatile metallic oxides, in order to drive off the mercury, promised well, this process was then tried in the following manner.

The dried salt was thoroughly mixed with a weighed quantity of cupric oxide in a platinum crucible and the filter placed on top. The whole was ignited, at first gently, then to low redness, at the mouth of a muffle,* then cooled, a few drops of nitric acid added to oxidize the cupric oxide reduced by the filter, and then re-ignited. The ignition was continued until the weight became constant. The increased weight was the phosphoric oxide ($P_2O_5$). After ignition the cupric oxide and phosphate came out of the crucible in a beautiful coherent mass, leaving it perfectly clean and unharmed.

*Disodic Phosphate.*—It is quite difficult to obtain this salt anhydrous. It becomes so between 30° and 40°, but, as it fuses at 35°, it must be repulverized for analysis, and as it is quite hygroscopic, it is liable to change during the operation. A quantity dried over sulphuric acid was used, the phosphoric oxide being determined by ignition.

| | | | per. ct. |
|---|---|---|---|
| (1) | 1·1130 grms. gave | ·4576 grms. $Na_4P_2O_7$ = | 21·98 $P_2O_5$ |
| (2) | 1·2355 " " | ·5075 " " = | 21·97 " |

The mercurous oxide process with cupric oxide gave the following results.

| | | | Found. | Theory. |
|---|---|---|---|---|
| (1) | 1·0245 grms. gave | ·5124 grms. $P_2O_5$ = | 50·01 | 50·00 |
| (2) | 1·2198 " " | ·4716 " " = | 38·66 | 21·97 |
| (3) | ·9200 " " | ·2018 " " = | 21·93 | " |
| (4) | 1·2423 " " | ·2730 " " = | 21·97 | " |

Number one was a specimen of anhydrous phosphate. It will be noticed that the second analysis is much too high. In this one the nitro-mercurous phosphate was placed in a mass in the center of the crucible and completely covered with cupric oxide. When the crucible was heated the cupric phosphate formed coated the outside of the pellet and prevented the further escape of the mercury. This proves the necessity of mixing thoroughly.

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* Justice is not done the muffle furnace. It gives an even, mellow heat which can be easily regulated, and for igniting precipitates it is unequaled. I have before spoken of the difficulty found in burning the filter with the aluminic phosphate. By placing it at the mouth of the muffle I was able to ignite it in the most perfect manner, without tipping the crucible, in less than ten minutes. Discretion must be used in placing the crucible in the muffle.

Care should be taken that the mercurous nitrate used is not basic. The salt used in this investigation was prepared in the following way. Pure mercury was dissolved, by aid of gentle heat, in pure nitric acid in a flat, open vessel. More mercury was now added and the whole boiled until every trace of nitrous acid was driven off. The solution was then allowed to crystallize. To the solution formed from these crystals metallic mercury is added to prevent the formation of mercuric nitrate. By this method the salt is obtained perfectly free from mercuric nitrate and the nitrites.

*Ammonio-sodic phosphate.*—As the ammonia present decomposes the mercurous nitrate, it is well to boil with a little caustic soda until it is driven off. In the first analysis magnesic oxide was substituted for the cupric oxide, but in every other respect the process was the same.

| | | | | Found. | Required. |
|---|---|---|---|---|---|
| (1) | 1·3500 grms. gave | ·3991 grms. | $P_2O_5$ | = 29·56 | 29·36 |
| (2) | ·9832 " " | ·2902 " | " | = 29·51 | " |
| (3) | 1·0803 " " | ·3181 " | " | = 29·44 | " |
| | | | Mean | 29·50 | |

*Ammonio-magnesic phosphate.*—The solution was freed from ammonia as in the previous case. By ignition the following results were obtained.

(1) ·5936 grms. gave ·3664 grms. $Mg_2P_2O_7$ = 43·00 pr. ct. $P_2O_5$
(2) ·6135 " " ·4123 " " = 42·99 " "

By the mercurous nitrate process I obtained the following results:

(1) 1·0785 grms. gave ·4627 grms. = 42·92 pr. ct. $P_2O_5$
(2) ·9500 " " ·4084 " = 42·98 " "
Mean 42·95

*Calcic phosphate.*—This salt was obtained by precipitating calcic chloride with an excess of disodic phosphate. The precipitate was then carefully washed and dried. This was dissolved in as little nitric acid as possible. If the solution is too acid the precipitate is not formed until sodic hydrate is added. The nitro-mercurous phosphate was ignited with magnesic oxide. By this means the following results were obtained:

(1) ·6190 grms. gave ·1606 grms. $P_2O_5$ = 25·94 pr. ct.
(2) ·6765 " " ·1755 " " = 25·96 "
Mean 25·95

Mr. Waldo Lincoln employed this process in making an analysis of bone earth, and permits me to cite his results. The nitro-mercurous phosphate was ignited with cupric oxide.

| | I. | II. | III. | IV. |
|---|---|---|---|---|
| Wt. taken | ·5586 | ·4312 | ·7025 | ·6969 |
| " $SiO_2$ found | ·0009 | ·0007 | ---- | ---- |
| " $P_2O_5$ " | ·2367 | ·1487 | ·2421 | ·2396 |
| Per cent $SiO_2$ | 0·16 | 0·16 | ---- | ---- |
| " $P_2O_5$ | 42·37 | 34·48 | 34·46 | 34·38 |

Mean of $P_2O_5$ in three analyses, 34·44

The first analysis presents another instance of failure on account of the precipitate not being properly mixed with the cupric oxide.

*Aluminic phosphate.*—This was prepared by adding an excess of disodic phosphate to a solution of potash alum. The precipitate thus obtained was carefully washed and dried. The phosphate was dissolved in the least possible quantity of nitric acid and then treated as in the previous cases. An excess of nitric acid must be carefully avoided. The precipitate was ignited with cupric oxide.

(1) ·5685 grms. gave ·1634 grms. $P_2O_5$ = 28·77 pr. ct.
(2) ·5827 " " ·1672 " " = 28·69 "
(3) ·6720 " " ·1927 " " = 28·68 "
Mean 28·71

In order to test the process thoroughly it was thought best to determine the composition of this salt and then to compare the found with the calculated percentage. The water was estimated by simple ignition.

(1) ·8689 grms. gave ·2624 grms. $H_2O$ = 30·18 pr. ct.
(2) ·8370 " " ·2525 " " = 30·17 "

The aluminic oxide was taken by difference yielding 41·12 pr. ct. These results lead to the formula

$$(Al_2O_3)_2(P_2O_5)+8H_2O$$
$$\text{or}\quad Al_2O_3+Al_2P_2O_8+8H_2O$$

showing it to be a basic aluminic phosphate.

| | Calc. pr. cts. | Found pr. cts. |
|---|---|---|
| $P_2O_5$ | 28·86 | 28·71 |
| $H_2O$ | 29·27 | 30·17 |
| $Al_2O_3$ | 41·87 | 41·12 |

I attempted to determine ferric and uranic phosphates in the same way, but on the addition of the sodic hydrate the metallic oxides were precipitated, rendering this method worthless for them. The iron solution was then very largely diluted and precipitated without the addition of sodic hydrate, but all of the phosphoric acid could not be thrown down. Next the ferric was reduced to the ferrous salt by the addition of metallic iron, by passing a stream of sulphydric acid through the solution, and by the addition of sulphurous acid, but without better results. The phosphate was dissolved in potassic cyanide and the ammonio-magnesian solution added to precipitate the phosphoric acid. I hoped that potassic ferrocyanide would be formed which would remain in solution and allow the phosphoric acid to combine with the potassium. The experiment, however, proved unsuccessful, and with these results the further investigation of ferric phosphate was suspended.

Although the ignition with cupric oxide leaves nothing to be desired in point of accuracy, and is a much quicker method than any now in use, yet it was thought that some other agent might be employed which would hasten the process still more.

Stannic oxide was tried for this purpose. To a weighed quantity of pure tin* the nitro-mercurous phosphate was added, then sufficient nitric acid, sp. gr. 1·170, was poured upon the mass to oxidize the tin completely. The whole was evaporated to dryness on a radiator, ignited and weighed. The plan seemed very promising, but the results, from some unknown cause, were far from being satisfactory.

Another idea was to fuse the nitro-mercurous phosphate with some substance which had a low fusing point, so that the mercury might be volatilized, the phosphoric oxide remaining. Accordingly it was fused with free sulphur but some of the phosphoric oxide was always volatilized. Potassic dichromate and plumbic chromate were both subjected to trial, but as the results were very unsatisfactory, further investigation in this direction was abandoned.

These results prove conclusively the value of this process for the estimation of phosphoric acid in all cases except those of ferric† and uranic phosphates.

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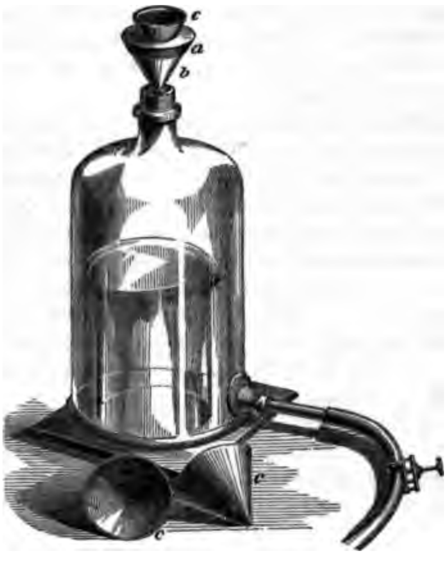
* Chemically pure tin can be obtained in considerable quantities, and with very little trouble, in the following manner. Ammonio-stannic chloride is first produced by adding to one molecule of stannic chloride, two of sal ammoniac. Dissolve in the least possible quantity of water and add an excess of chlorhydric acid, which causes the double chloride to crystallize out immediately. Purify completely by recrystallization from acid solutions. Dry the salt at 120°. Then fuse with an equal weight of a mixture of one part of potassic cyanide and one of potassic carbonate in a porcelain crucible On cooling a button of chemically pure tin will be found.

† Rose proposes in the case of ferric phosphate, to fuse the mercurous phosphate obtained with the mixed carbonates; then dissolve in dilute chlorhydric acid, and precipitate with the ammonio-magnesian solution. This will not effect a complete separation.

Otto's process of precipitating the phosphoric acid as ammonio-magnesic phosphate in the presence of tartaric acid was modified and tested as follows: Ferric phosphate was prepared by precipitating ferric chloride with disodic phosphate. The precipitate was thoroughly washed by decantation and then evaporated to dryness. By this means the phosphate was obtained as a light yellow powder. A weighed quantity of this was dissolved in dilute chlorhydric acid, sufficient tartaric

## § 3. *On the use of Porous Cones in Filtration.*

The sulphides of arsenic and antimony being quite easily obtained have long been regarded as furnishing the readiest and best means for the estimation of these two elements. A serious objection has however arisen in the fact, that they must be determined upon weighed filters, and that paper filters cannot be dried above 100° without danger of loss. Hence a filter which could be weighed easily and withstand a high temperature became a desideratum.



Taylor* accomplished this with sand filters, and obtained some excellent results. This method, however, requires experience and careful manipulation, reasons which will probably prevent its being generally used.

Under these circumstances the idea of using a cone made of very porous earthenware, and as a substitute for the paper filter, presented itself to me, and has been carried out in the following manner.

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acid added to keep the whole of the iron in solution, next ammonia in excess, the solution was then heated till it boiled briskly, and the ammonio-magnesian solution was added. The precipitate was ignited and weighed as magnesic pyrophosphate. This method gave the following results.

(1) ·6084 grms. gave ·3437 grms. $Mg_2P_2O_7$=36·13 per cent. $P_2O_5$
(2) ·7411 " " ·4173 " " =36·02 " "
(3) 1·0294 " " ·5805 " " =36·11 " "

Mean 36·09.

I would call especial attention to the fact, as it shortens the process considerably, that the phosphate solution was boiling when the ammonio-magnesian solution was added. Dr. Gibbs found that when the ammonio-magnesic and ammonio-manganic phosphates were precipitated from boiling solutions, that on cooling they came down as beautiful, highly crystalline precipitates, which, instead of requiring twenty-four hours for precipitation, were ready to be filtered within an hour. This method has been in use in this laboratory for the past six months, and I has met with uniform success. It applies as well to the estimation of phosphoric acid as to that of magnesium and manganese.

With this additional treatment for the separation of iron, it is believed that this process will apply to the majority of cases met with in practice.

* This Jour. II, vol. xliv, p. 215.

The cones* are made of very light, porous earthenware, and have an angle of about sixty degrees. They are used in the following way:

A section of a seamless rubber tube *a*, is stretched around the mouth of a funnel *b*, preferably a Bunsen funnel, allowing a portion of the tube to project above the top. This part will immediately arrange itself at right angles to the top of the funnel; into the circle thus formed the cone *c*, is put. It is then connected with the Bunsen pump. When the cone is moistened and the pressure applied, the rubber band forms an air-tight joint and the liquid runs through with great rapidity. Before the cones are applied to quantitative work they must be carefully washed, first with concentrated chlorhydric acid, then with distilled water, dried, and weighed. A small porcelain crucible was always kept at the balance in which to weigh them. With this apparatus the following results have been obtained.

A sample of ordinary crystallized potassio-antimonylic tartrate gave

(1) 1·1069 grms. gave ·5570 grms. $Sb_3S_3$=35·94 pr. ct. Sb.
(2) 1·6985 " " ·8550 " " =35·96 " "
Mean 35·95.†

A specimen of the same salt carefully recrystallized, gave upon analysis the following data.

(1) ·7755 grms. gave ·3955 grms. $Sb_2S_3$=36·40 pr. ct. Sb.
(2) ·6050 " " ·3085 " " =36·42 " "
Mean 36·41.

Mr. W. Lincoln also made an analysis of the same salt by means of the cones, and kindly permits me to use his results.

(1) ·4683 grms. gave ·2388 grms. $Sb_2S_3$=36·41 pr. ct. Sb.
(2) ·8135 " " ·4144 " " =36·38 " "
Mean 36·40.

In all of these analyses Sb=120.

The $Sb_2S_3$ was precipitated in the manner recommended by Sharples.‡ It is necessary that the boiling should proceed for some time, a brisk current of sulphydric acid being passed through the liquid. The precipitate is then filtered upon the weighed cone and the whole dried in an air bath at 300°. The antimonous sulphide is at this temperature converted into the gray crystalline modification.

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* Much credit is due to the firm of A. W. & H. C. Robertson of Chelsea, Mass., who, by their superior mechanical skill, have aided me much in accomplishing the desired result.

† Taylor obtained as the mean of three analyses 36·08.

‡ This Jour., II, vol. I, page 248.

No formula has yet been found which agrees with either of the percentages obtained. As the atomic weight of antimony is differently stated from 120 to 122, this is easily explained.

It is unfortunate that the atomic weight of antimony is yet so uncertain, but it is hoped that these results, agreeing so closely among themselves, will be accepted as proving the value of the process.

*Arsenous Oxide.*—This was the next substance analyzed. The sulphide was precipitated in the usual manner, but it was noticed that by having the solution decidedly acid and passing through it a very rapid stream of sulphydric acid, that the sulphide was obtained in a more granular condition.

The precipitate can be dried with impunity at 120°. At 140° the lemon-yellow sulphide commences to change to red, and at 180° is completely converted into the liver-red variety.

With ordinary commercial arsenous oxide, the following results were obtained.

| | | | Found pr. cts. | Theory pr. cts. |
|---|---|---|---|---|
| (1) | 1·7940 grms. | gave 2·2260 grms. $As_2S_3$ | =75·64 | 75·76 As. |
| (2) | ·5770 " | " ·7165 " " | =75·84 | " " |
| (3) | ·8520 " | " 1·0579 " " | =75·68 | " " |
| | | Mean 75·72 | | |

Mr. Lincoln obtained as the result of two analyses:

| | | | Found pr. cts. | Theory pr. cts. |
|---|---|---|---|---|
| (1) | ·8926 grms. | gave 1·1087 grms. $As_2S_3$ | =75·76 | 75·76 As. |
| (2) | ·8145 " | " 1·0128 " " | =75·77 | " " |
| | | Mean 75·76 | | |

These results show that this process renders the estimation of antimony and arsenic one of the simplest and most accurate operations in quantitative analysis.

The cones can be used repeatedly and can replace paper filters in every case. They will undoubtedly be found to be of great value in commercial work, for drying crystals and filtering corrosive liquids. As they will stand sudden changes of temperature without breaking, they can be substituted to advantage in many cases for crucibles.

In closing, I desire to return my sincere thanks to my kind teacher, Dr. Gibbs, who has furnished me with the material for these investigations, and has aided me by his counsels and advice.

Cambridge, March 13th, 1871.

## ART. L.—*On certain Glacial and Post-glacial phenomena of the Maumee Valley;* by G. K. GILBERT, A.M.

THE observations, upon which the following remarks are chiefly based, were made during the summers of 1869 and 1870 for the Ohio Geological Survey, and are here published, with permission, in advance of the official report.

I. The Maumee occupies a broad shallow valley with easy slopes and without definite boundaries. It is the westward prolongation of the trough occupied by Lake Erie, and includes the upper waters at least of the Wabash river as well as the entire basin of the Maumee. The highest point along the axis of the valley is at Fort Wayne, one hundred miles from Lake Erie, and is but 185 feet above the present level of that lake, so that the descent of the Maumee eastward is less than two feet per mile; the sides of the valley rise with a slope nearly as moderate to an altitude of 300 to 400 feet above the median line. So nearly does it approximate to a plain that the consequences of the earth's sphericity are not cancelled, and an observer on one side is prevented from seeing the opposite by the interference of the intervening land.

The rock surface is covered by a sheet of drift, that masks its minor irregularities and contributes to the general impression of a plain. Where the drift has been freshly removed by the wash of waves or currents, the surface of the underlying rock is shown to be planed, striated, and furrowed by glacial action. The general bearing of the striæ, subject to local deflection from details of contour, is parallel to that of the valley. At Sandusky City, and on Kelley's, South Bass, and West Sister Islands it is S. 80° W.; at Fremont and Genoa, east of Toledo, S. 65° W.; at various points in Lucas county, west of Toledo, S. 55° W.; and along the Auglaize river near Defiance, S.W. Farther south the bearing is still more southerly, being S. 35° W. at Lima, O., and S. 15° W. at Middlepoint near Van Wert. That the motion to which this system of striæ is due was southwestward—up the valley of the Maumee as it now lies,—and not in the opposite direction, is attested by some flint nodules contained in limestones of the Waterlime Group on West Sister island and at Monclova near Toledo. By reason of their superior hardness, they were able to resist, better than the limestone, the grinding action, and they project boldly from the planed surfaces, protecting and maintaining each upon its west or lee side, a train or ridge of undisturbed limestone.

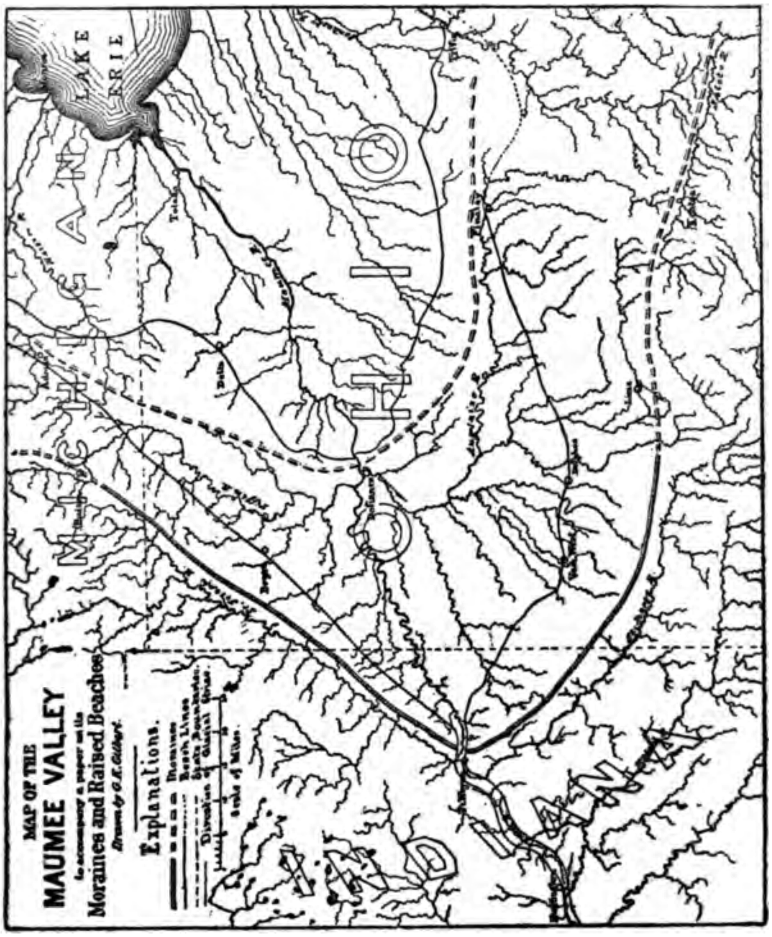
The overlying drift is in chief part a blue clay—the Erie Clay of Sir William Logan—containing irregular, lenticular beds of sand and gravel, and abundant, but unequally distributed, glaciated boulders of all sizes up to a diameter of twenty feet. It has already been recognized by Dr. Newberry as the sediment of a sea or ocean flanked by glaciers and floating rock-laden icebergs; and every phase that has fallen under my own observation has served to confirm the identification. Its more elevated portions, which have been exempt from lacustrine action, present a rolling surface with frequent, undrained hollows, occupied by lakelets or the deep swamps that have resulted from their slow filling; while at and below the level of 220 feet (above Lake Erie) this surface has been remodelled and levelled by the waves, currents and sediments of Lake Erie.

Premising thus much of the general character of the valley, I will now ask the reader to notice, upon the accompanying map, some peculiarities of the arrangement of the watercourses. North of the Maumee river, where the land slopes to the southeast, most of the rivulets flow in that direction; but the principal streams, the St. Joseph and Tiffin rivers, cross the system at right angles. Moreover, all the tributaries of the St. Joseph come from the northwest, while the country east of it is drained by branches of the Tiffin, the divide between the waters of the two streams running within five miles of the former. This feature is caused by a narrow step in the country,—a natural embankment, that carries the St. Joseph across the face of the slope, as a mill-race is carried along the bank of a stream; and that river may be said to result from the confluence of eastward-flowing creeks that have found a barrier in the ridge which forms its eastern bank. The slopes of this ridge are quite gentle and the height is moderate; west of Bryan, where it is crossed by a branch of the Lake Shore and Michigan Southern Railway, it rises to an altitude of fifty feet, while at the north line of Ohio it is barely distinguishable. Superficially it everywhere presents the same rolling gravelly clay as the surrounding country.

South of Fort Wayne the same phenomena are presented by the St. Marys river. The slope of the country is toward the northeast, yet its course is to the northwest. Its tributaries are from the south and west, while its right bank is drained by branches of the Auglaize. Where the dividing ridge has been measured, it has an altitude of 35 to 50 feet.

A correlated feature of the two streams—the St. Marys and St. Joseph—is that, forming the sides of a right angle, they unite at its apex, and the resultant river returns within the angle.

The page of history recorded in these phenomena is by no means ambiguous. The ridges, or, more properly, the ridge which determines the courses of the St. Joseph and St. Marys rivers is a buried terminal moraine of the glacier that moved southwestward through the Maumee valley. The overlying Erie Clay covers it from sight, but it is shadowed forth on the surface of that deposit, as the ground is pictured through a deep and even canopy of snow. Its irregularly curved outline accords intimately with the configuration of the valley, and with the direction of the ice markings; its concavity is turned toward the source of motion; its greatest convexity is along the line of least resistance. The notch at Fort Wayne, through which the Maumee flows, was perhaps first cut by the river to which the retiring glacier gave rise, but has certainly been cleaned of the subsequent deposit of clay by a later current,—



to be described farther on. While it affords no section of the moraine for examination, it yet confirms the general fact of its existence, by demonstrating that the superficial ridge has here no nucleus of rock *in situ*. With the exception of the Maumee, no stream crosses the moraine from near Hudson, Michigan, to Fort Amanda, near Lima, Ohio, a distance of 83 miles in a right line and 120 miles on the line of the moraine. Beyond these points I have not traced it, but an inspection of the map suggests that it may be found along the upper waters of the Tiffin and Scioto rivers, as dotted in the accompanying chart. This would increase its length and chord to 200 miles, and 120 miles, respectively.

The courses of the Tiffin and Auglaize rivers are determined by a more easterly, and so more recent, moraine of the same system, but its form is less conspicuous, as this portion of the valley has been greatly modified by lacustrine action. The same agency has obliterated all superficial traces, if any existed, of minor moraines.

South of the St. Marys river are other and numerous moraines accompanied by glacial striæ. Their character and courses have not yet been studied; but their presence carries the mind back to an epoch of the cold period, when the margin of the ice-field was farther south, and the glacier of the Maumee valley was marged in the general mass. As the mantle of ice grew shorter—and, in fact, at every stage of its existence—its margin must have been variously notched and lobed in conformity with the contour of the country, the higher lands being first laid bare by the encroaching secular summer. Early in the history of this encroachment the glacier of the Maumee valley constituted one of these lobes, and has recorded its form in the two moraines that I have described.

II. That Lake Erie formerly had an outlet past Fort Wayne, Indiana, and down the Wabash valley, has for some years been recognized by local observers;* but, as there is reason to believe that the fact is as yet unpublished, an account of it will not be without interest to the public. I was led to make an examination of this outlet by its relation to certain cotemporaneous beach lines that I had occasion to examine and trace in Ohio.

The relation of the waters of the Great Lakes to their shores has undergone a series of changes since it was first established, by the recession or drainage of the iceberg-bearing sea, at the close of the Drift period. Some of these changes appear to have been gradual and others comparatively sudden, while the intervals of rest are plainly marked by the beach lines, of which a series is presented near the borders of each of the lakes, outlining their ancient limits. In the Maumee valley four of these periods of rest are distinctly recorded, the water levels being marked at 220, 195, 165 and 90 to 65 feet, above Lake Erie, along the line of the Air Line branch of the Lake Shore and Michigan Southern Railway, running west from Toledo. Two of these beach lines have been traced for some distance across the country, and their courses are marked on the accompanying map.* The lower of the two is the one at 165 feet. Lake Erie then stretched sixty miles up the valley to the site of the town of Defiance, covering all that country now known as the Black Swamp. The upper beach is the highest of the series, and records a lake level at Adrian, Bryan and Columbus Grove of 220 feet above the present, of 210 feet at Delphos, and of 205 feet at New Haven, six miles east of Fort Wayne. Toward the latter point the beach lines converge, coming from the northeast and southeast; but, instead of uniting, they become parallel, and are continued as the sides of a broad water-course, through which the Great Lake Basin then discharged its surplus waters. At New Haven this channel is not less than a mile and a half broad, and has an average depth of 20 feet, with sides and bottom of drift. For twenty-five miles this character continues, and there is no notable fall. Three miles above Huntington, Indiana, however, the drift bottom is replaced by a floor of Niagara limestone, and the descent westward becomes comparatively quite rapid. At Huntington the valley is contracted in width to one mile, and is walled, on one side at least, by rock *in situ*. In the eastern portion of this ancient river bed the Maumee and its branches have cut channels fifteen to twenty-five feet deep, without meeting the underlying limestone. Most of the interval from Fort Wayne to Huntington is occupied by a marsh, over which meanders Little river, an insignificant stream whose only claim to the title of river seems to lie in the magnitude of the deserted channel of which it is sole occupant. At Huntington the Wabash river emerges from a narrow cleft of its own carving, and takes possession of the broad trough to which it was once but a humble tributary. The limestone above Huntington is the rocky rim or dam which determined the altitude of the overflow at this point, and is 170 feet above the present level of Lake Erie. Above it the stream must have resembled the Detroit, bearing a smooth surface, but with enough current to excavate its soft bottom somewhat deeply where the marsh and prairie of the Little river now are spread; below, it was more comparable to the Niagara at Buffalo, where it rushes over the outcrop of the Corniferous limestone. At Fort Wayne the St. Joseph and St.

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* The fact was suggested to me before I visited the locality, by Martin Arrowsmith, Esq., of Farmers' Centre, O., and was realized less perfectly by several gentlemen whom I met in Indiana.

Marys contributed their waters. Their mouths were more than fifty feet higher than now, and the flood-plains of gravel and sand, which they then formed, now flank their valleys as terraces, and can be traced for forty miles toward their sources. When, by the retiring of the lake, they were united, but slight cause was needed to turn them eastward along the level bottom of the deserted channel, and they have now cut their beds so deeply in the drift, that the highest freshets do not connect them with the Little river.

In addition to its general interest, the fact of this ancient, southwesterly lake-discharge is an important element in the study of the nature of the changes, in virtue of which the lakes have stood at so many different levels since the ice-period. The idea suggested by Dr. Newberry (in a paper before the Boston Society of Natural History in 1862), that they may have been due to local, rather than continental, upheaval and depression, receives here strong confirmation. At the point where Lake Michigan once found outlet southward through the Desplaines river,* the rocky barrier is but four feet above the present level of that Lake, and seventeen feet above Lake Erie. A barrier of drift may have existed one hundred feet higher. At the Wabash outlet the rocky rim is 170 feet above Lake Erie, and was probably covered by fifty feet of drift. And at Lewiston, where the Niagara commenced its work, the elevation of the rim is 38 feet higher than the present Lake.†

The order in which these channels were opened and deserted, is not yet known, but whatever sequence is supposed, it is equally evident that the changes that produced it must have involved the tilting and warping of the land. At whatever time the Wabash valley received the discharge, the barriers, east and west, must have been relatively much higher than at present. To restore now the old water level and current at Fort Wayne, we would need, not merely to fill the gorge of the Niagara, and renew the escarpment at Lewiston, but to construct on that escarpment a retaining wall 170 feet high and many miles in length; and, after filling the valley of the Desplaines to the height—one hundred feet—of the adjacent drift hills, another hundred feet would be needed to complete the dam. Just what has been the warping of the basin to produce this contortion of the rim, I am not prepared to say, but the problem is not insoluble. The lines of bluffs, shingle, ridges and dunes, that mark the limits of the water at its various stages, are plain and faithful records, and their tracing cannot fail to throw light on the character and the order of the undulations which have affected the valley of the lakes in post-glacial time. The field for exploration is large, and the data already accumulated inconsiderable, but we may hope the geological surveys now in progress in Ohio, Indiana and Michigan, and in Canada, will in a few years develop the whole subject.

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* This outlet is described by Dr. E. Andrews in his recent paper on "The North American Lakes considered as chronometers of post-glacial time" (Trans. Chicago Acad. Sci., vol. ii, p. 14); and the additional data here given in regard to it were kindly furnished me, by the same gentleman, in a private letter.

† Nat. Hist. of New York, Geology of Fourth District. By James Hall, p. 384. It is interesting to note, in passing, that the containing rock was in each case the Niagara limestone. and that a deep gorge has been cut at Niagara only, because there alone was an underlying softer rock exposed.

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## Art. LI.—*Memorandum on the Amphipleura pellucida;* by J. J. Woodward, Assistant Surgeon, U. S. Army.

The attention of microscopists has frequently been directed, of late years, to the *Amphipleura pellucida* or *Navicula acus*, as a test object well suited to try the defining powers of the very best object glasses. The length of this diatom is stated by Pritchard as ranging from $\frac{1}{140}$th to $\frac{1}{300}$th of an inch. The average length is given by the Micrographic Dictionary at ·0044 of an inch. The striæ, which are exceedingly difficult, were first described by Messrs. Sollitt and Harrison, who estimated them at from 120,000 to 130,000 to the inch. Their estimate has been adopted by the Micrographic Dictionary and by the majority of modern writers who have referred to this test; but so many difficulties beset the resolution that few microscopists appear to have attempted to verify the original estimates. Indeed most observers would seem to have been unsuccessful in their efforts to resolve the Amphipleura even with the best objectives and some have gone so far as to deny the existence of any striæ upon the frustules of this species.

Among the microscopists who claim to have seen the striæ, several would seem to differ from the original estimates of Sollitt and Harrison as to their fineness. Dr. Royston Pigott, whose papers on "high-power definition" in the Monthly Microscopical Journal have recently attracted much attention, sets down their number at 150,000 to the inch. Dr. Carpenter, on the other hand, in the 4th edition of "The Microscope and its Revelations," expresses the opinion that even the estimates of Messrs. Sollitt and Harrison are too high: and we are told by Mr. Lobb (Monthly Microscopical Journal, vol. iii, p. 104) that Mr. Lealand has recently "succeeded in counting the Amphipleura lines and finds them 100 in $\frac{1}{1000}$th of an inch."

A few months ago two slides of *Amphipleura pellucida* were received at the Army Medical Museum from Messrs. Powell and Lealand, and I succeeded in obtaining excellent resolution by the immersion $\frac{1}{16}$th of these makers. The frustules on the two slides were found to measure from $\frac{1}{170}$th to $\frac{1}{400}$th of an inch in length. Resolution could be satisfactorily effected and the striæ counted on any of them. I took eight successful negatives from medium size and small frustules, and verified the counts made in the Microscope by counting the striæ on the glass negatives. I found the striæ on medium sized frustules, say $\frac{1}{200}$th of an inch in length, counted usually from 90 to 93 striæ to the $\frac{1}{1000}$th of an inch; in that selected for the two photographs which accompany this memorandum the number was 91 to the $\frac{1}{1000}$th of an inch. Larger frustules exhibited rather coarser, smaller ones rather finer striæ. On the smallest frustules at my disposal, several of them only $\frac{1}{400}$th of an inch in length, I found no example in which the number of striæ exceeded 100 to the $\frac{1}{1000}$th of an inch. The striæ of these smallest and most difficult frustules do not then rival in fineness the nineteenth band of the Nobert's plate, as has been asserted by some; they compare rather with the sixteenth and seventeenth bands.

After making the photographs I extended my observations to a number of other slides of *Amphipleura pellucida* including two of the original specimens from Hull, kindly sent to the Museum some time since by Mr. W. S. Sullivant, of Columbus, Ohio, and the example in the First Century of Eulenstein. I found that different slides varied considerably in the ease with which I could resolve them, chiefly as I think on account of the thickness of the glass covers, which in several instances did not permit the best work of the immersion $\frac{1}{16}$th. Perhaps, however, the markings on some frustules may be shallower than on others whose striæ count the same number to the $\frac{1}{1000}$th of an inch. In any event I have found, as yet, no slides the covers of which permit the $\frac{1}{16}$th to be appproximately adjusted, on which it was impossible to resolve the frustules, and no frustules the striæ of which exceeded 100 to the $\frac{1}{1000}$th of an inch.

The best resolution I was able to obtain by ordinary lamp light was not very satisfactory. I used therefore, during the investigation, direct sunlight, rendered monochromatic by passage through the solution of ammonio-sulphate of copper. A parallel pencil of such light was concentrated by the achromatic condenser, which was suitably decentred to attain obliquity. The same illumination was employed in making the photographs. I have since had the pleasure of exhibiting the resolution in quite as satisfactory a manner to several microscopists by monochromatic light obtained from the electric lamp.

**War Department, Surgeon General's Office,**
**Army Medical Museum, Feb. 1, 1871.**

## ART. LII.—*Memorandum on the Surirella gemma;* by J. J. WOODWARD, Assistant Surgeon, U. S. Army.

THE *Surirella gemma* has been recommended by Hartnack as a test for immersion objectives of high powers. I have not gained access to his original description, but find accounts of his views, with figures, in the works of Drs. Carpenter and Frey. ("The Microscope and its Revelations," 4th edition, p. 182. "Das Mikroskop," 3d edition, p. 40.) Hartnack observed fine longitudinal striæ in addition to the fine transverse ones previously known to exist between the large transverse ribs; he supposed the true markings to have the form of elongated hexagons.

Two handsome slides of this diatom were received at the Army Medical Museum a few months since, from Bourgogne of Paris. A careful study of these by monochromatic sunlight inclines me to the opinion that Hartnack's interpretation is erroneous, and that the fine striæ are in reality rows of minute hemispherical bosses; from which, as in the case of other diatoms, the appearance of hexagons would readily result if the frustule was observed by an objective of inferior defining power to that I used, or if the illumination was unsuitable. This memorandum is accompanied by two photographs exhibiting what I saw; one is magnified 1,034, the other 3,100 diameters. The principal frustule shown in these photographs is $\frac{1}{200}$th of an inch in length. (The mean length of *S. gemma* is stated by the Microscopic Dictionary at $\frac{1}{240}$th of an inch.) The fine transverse striæ counted longitudinally at the rate of 72 to the $\frac{1}{1000}$th of an inch. Transversely these were resolved into beaded appearances which counted laterally 84 to the $\frac{1}{1000}$th of an inch. If the structure consists, as I suppose it does, of fine hemispherical bosses, projecting from the surface of the frustules, the fact that these bosses are set together more closely in the transverse direction than in the longitudinal would account for the elongated form of the pseudo-hexagons when seen.

Some parts of the photographs closely approach Hartnack's description, but it is easy to observe that these are not the parts which are most nearly in focus.

I have also resolved this diatom by monochromatic light derived from the electric lamp. The appearances obtained were identical with those above described.

**War Department, Surgeon General's Office,**
**Army Medical Museum, Feb. 1, 1871.**

## LIII.—*Calorimetric Investigations;* by R. BUNSEN.*

(Continued from page 282.)

### 2. *The Determination of specific heat.*

The simplest way of obtaining the specific heat of a substance is to determine once for all the amount of heat, expressed in scale divisions, which *one* gram of water loses in cooling from 1° C. to 0° C., and to divide by the value $W_w$ thus formed, the quantity of heat W, measured on the same scale, which one gram of the substance loses for the same difference in temperature. If the weight of the substance is G, its temperature *t*, the number of corrected divisions which the mercury thread of the scale has advanced T, then the specific heat desired results from the equation $S = \frac{T}{W_w G t}$, - - - - - (6)

in which, for *t*, the boiling point of water, corresponding to the state of the barometer during the experiment, is to be taken.

In order to communicate to substances the constant temperature *t*, use is made of the apparatus, fig. 4 (p. 173), which is drawn to a scale of $\frac{1}{6}$ of its real size. The tin vessel A, which is provided with a water guage, contains as much water as is necessary in order that, by means of the small gas lamp underneath, a continual jet of steam of 12 hours duration may be produced. The steam enters through the rubber tube *a*, and the outer glass vessel B into the rubber tube *b*, which communicates with an ordinary condenser. Within the vessel B, which is filled with continually renewed steam, is the heating vessel *f*, in the form of an ordinary thin walled test-tube whose upper opening is not widened out but somewhat narrowed and cut off sharply. The opening projects several millimeters above the rubber stopper closing the outer vessel B. When the body to be warmed has remained in the vessel *f*, which is surrounded on all sides by steam, about one hour, then the whole apparatus, through which the steam still flows, is held by means of the cork ring *n*; the still closed mouth *p* is on the likewise closed mouth *δ* (fig. 1) of the snow-surrounded calorimeter, the stoppers are rapidly removed, while almost simultaneously, by tilting the heating apparatus B, the heated body is allowed to fall into the water *a*, fig 1. The time consumed in falling amounts to only a very small fraction of a second, so that the cooling during the same may be considered as vanishingly small.

On the bottom of the inner vessel *a*, fig 1, is contained a small, perfectly moistened plug of loose cotton wool, which, to prevent its rising, is twisted around a coiled platinum wire. This cotton answers a double purpose: in the first place it prevents the glass vessel from being injured by the falling in of specifically heavy bodies; then in addition it aids in the removal from the apparatus of the substances which have been used in the experiment. To effect this, a properly bent wire is bored into the cotton, which, with the substance resting upon it, is drawn therewith to the mouth of the tube, the substance is removed and the cotton without being taken out of the vessel is returned by means of the wire to its former place.

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* Translated for this Journal, with permission of the author, from Poggendorff's Annalen der Physik und Chemie, Bd. cxli, by Dr. G. E. MOORE, of San Francisco.

The principal advantage, which, independent of its great delicacy, the instrument just described possesses over all other calorimetric contrivances is, that the entire heat which the heated body evolves is employed, without any loss, in the ice melting: the weights of the substances which give up their heat to the 0° C. cooled water of the vessel *a*, fig. 1, is so small compared with the weight of this water, that the temperature can never rise to 4° C. As the water has at this temperature its maximum density, the fluid which warms itself on the bottom of the vessel *a* can never rise, and is protected from every loss of heat, not employed in ice melting, by a high superincumbent water column at 0° C., whose conducting capacity for heat is vanishingly small. This circumstance may be observed very beautifully on the ice cylinder, when it has been used for 30 to 40 experiments. There is then to be found in the ice, quite far down on the bottom, where the vessel *a* is rounded off, a hollow space, melted out and filled with water, which possesses the very regular form of a small glass matrass, while the ice cylinder above this part appears throughout its whole extent entirely unaltered.

The weight of the substance to be investigated need be, according to the specific heat to be expected, no greater than 0·3 grams, to at most 4 grams. If the substance is a fluid, or if it is subject to alteration by the access of air or water, it is, as in an organic analysis, sealed in the lightest possible glass case, whose weight is determined in weighing the substance. If the substance floats on water, either above or with the enclosing glass case, it is loaded in addition with a likewise weighed spiral of platinum wire, heavy enough to effect the immersion. It would probably be still more convenient to employ in all cases a light, tightly closing platinum vessel. The amount of heat which the glass case and platinum spiral emit is included in the calculation in the following manner: Let the weight of the glass case be called $G_g$, its temperature *t*, and the amount of heat, measured in scale divisions, which one gram of the glass of the case emits on cooling from 1° C. to 0° C. $W_g$, and let the same factors for platinum be denoted by $G_p$, $t$ and $W_p$, then equation (6) will be transformed into

$$S=\frac{\frac{T}{t}-(W_gG_g+W_pG_p)}{W_gG} \quad \text{- - - -} \quad (7)$$

The constants $W_g$, $W_p$ and $W_w$ are first to be determined (once for all), $W_p$ results with the aid of the equation

$$W_p=\frac{T}{Gt}$$

from the following observations, in which G denotes the weight of platinum employed in the experiment:

$$T=215{\cdot}6$$
$$t=100^\circ{\cdot}0 \text{ C.}$$
$$G=4{\cdot}5942 \text{ grams}$$

whence: $W_p=0{\cdot}4692$

$W_g$ was calculated by the same equation from the following observations conducted on two kinds of glass, by which the weight of glass employed in the experiment is denoted by G, and the elements for the determination of T according to equation (5) are likewise given.

TABLE 2.

| | | Glass, kind I. | Glass, kind II. | |
|---|---|---|---|---|
| | | Expt. 1. | Expt. 2. | Expt. 3. |
| Weight of the glass, - - | $G$ | 0·5706 grm. | 1·0114 grm. | 1·4319 grm. |
| Temperature of the glass, - | $t$ | 99°·74 C. | 99°·474 C. | 99°·474 C. |
| Duration of the experiment, - | $M_1-M_0$ | 29′ | 87′ | 56′ |
| Movements on scale before the experiment, - - - - | $\frac{\tau_0}{m_0}$ | −0·1 | 0·0 | +0·005 |
| Movements on scale after the experiment, - - - - | $\frac{\tau_1}{m_1}$ | −0·1 | 0·0 | +0·014 |
| Oscillation on the scale, - | $Q_0-Q_1$ | 159·1 | 287·9 | 410·4 |

For the first sort of glass, $W_g=2{\cdot}7446$;
for the second $W_g=2{\cdot}8616$
$W_g=2{\cdot}8777$

Mean 2·8697

$W_w$ is obtained from the two following experiments by means of the equation

$$W_w=\frac{\frac{T}{t}-(W_gG_g+W_pG_p)}{G}$$

TABLE 3.

| | | Expt. 1. | Expt. 2. |
|---|---|---|---|
| Weight of the water, - - | $G$ | 0·3333 | 0·3333 |
| Weight of the glass case, - | $G_g$ | 0·2223 | 0·2223 |
| Weight of the platinum load, | $G_p$ | 0·5230 | 0·5230 |
| Temperature communicated, | $t$ | 99°·474 C. | 99°·474 C. |
| Duration of the experiment, - | $M_1-M_0$ | 76′ | 86′ |
| Movements on the scale before the experiment, - - - | $\frac{\tau_0}{m_0}$ | 0·0 | +0·067 |
| Movements on the scale after the experiment, - - - | $\frac{\tau_1}{m_1}$ | 0·0 | +0·064 |
| Observed divisions on the scale, | $Q_0-Q_1$ | 573·9 | 568·1 |
| Constants, - - - | $W_p=0{\cdot}4692$; $W_g=2{\cdot}870$ | | |

The calculation gives: from experiment 1: $W_w=14{\cdot}660$
" " 2: $W_w=14{\cdot}654$
in the mean $W_w=14{\cdot}657$

For the explanation of the method already described, I append the results of several determinations conducted on chemically pure substances, whose specific heat has been determined with great accuracy by the previously customary method of mixture. The elements of observation in these experiments are to be found arranged in the following table 4, whose lettering relates to equations (5) and (7).

TABLE 4.

| Substance investigated. | | Cast silver. | Cast zinc. | Cast antimony. | Cast cadmium. | Very old roll sulphur |
|---|---|---|---|---|---|---|
| Weight of the substance, | $G$ | 3·6320 | 2·5150 | 3·8575 | 1·8675 | 1·0708 |
| Weight of the glass case, | $G_g$ | 0 | 0 | 0 | 0 | 0 |
| Weight of the platinum load, - - | $G_p$ | 0 | 0 | 0 | 0 | 0 |
| Temperature communicated. - - | $t$ | 100°·00 C. | 99°·80 C. | 99°·80 C. | 99°·80 C. | 100°·00 C. |
| Duration of the experiment, - - | $M_1-M_0$ | 60′ | 60′ | 64′ | 63′ | 55′ |
| Movements on scale before the experiment, | $\frac{\tau_0}{m_0}$ | 0 | 0 | 0 | 0 | 0 |
| Movements on scale after the experiment, | $\frac{\tau_1}{m_1}$ | 0 | 0 | 0 | 0 | 0 |
| Oscillation on the scale, | $Q_0-Q_1$ | 297·7 | 343·8 | 279·5 | 146·7 | 268·8 |
| Constants, - | $W=14{\cdot}657$ | | | | | |

In the following table 5, are to be found the specific heats computed from these values, together with the ones found by Regnault by the method of mixture.

TABLE 5.

| Substances. | Ice calorimeter. *a.* | Regnault. *b.* | *a—b.* |
|---|---|---|---|
| Water, | 1·0000 | 1·0000 | .... |
| Silver, | 0·0559 | 0·0570 | —0·0011 |
| Zinc, | 0·0935 | 0·0956 | —0·0021 |
| Antimony, | 0·0495 | 0·0508 | —0·0014 |
| Cadmium, | 0·0548 | 0·0567 | —0·0019 |
| Sulphur, | 0·1712 | 0·1764 | —0·0052 |

It will be seen that the values obtained with the ice calorimeter agree very closely with those obtained by Regnault by means of the method of mixture, but have always been found somewhat smaller. Whether this constant deviation has its origin in the difference in the methods employed can be the less decided from these few experiments as they were conducted, to be sure with the avoidance of all considerable sources of error, but without special care, while I was at the same time occupied in other labors.

The following table 6, contains experiments made with several pure elements whose specific heats could not previously be determined. The specific heats and atomic heats calculated therefrom, are arranged together in table 7.

TABLE 6.

| tance investigated. | | Indium. | Indium. | Ruthenium. | Calcium. | Calcium. | Allotropic tin. | C |
|---|---|---|---|---|---|---|---|---|
| t of the substance, | G | 1·1514 | 1·1514 | 1·7927 | 0·2823 | 0·2823 | 2·2394 | 3 |
| t of the glass en-p, | $G_g$ | 0 | 0 | 0·3287 | 0·6683 | 0·6683 | 0·3953 | |
| t of the platinum, | $G_p$ | 0 | 0 | 0·4239 | 0·4239 | 0·4239 | 0 | |
| rature communi-d, | *t* | 99°·78 C. | 99°·82 C. | 99°·60 C. | 99°·78 C. | 99°·78 C. | 99°·786 C. | 99° |
| on of the experi-t, | $M_1-M_0$ | 46′ | 47′ | 106′ | 65′ | 76′ | 66′ | |
| nents on the scale re the experiment, | $\frac{\tau_0}{m_0}$ | —0·130 | —0·063 | —0·160 | —0·090 | —0·052 | —0·120 | 0 |
| nents on the scale the experiment, | $\frac{\tau_1}{m_1}$ | —0·020 | —0·037 | —0·110 | —0·130 | —0·076 | —0·16 | 0 |
| tion on the scale, | $Q_0-Q_1$ | 100·2 | 97·5 | 276·8 | 280·2 | 277·3 | 296·0 | 2 |
| nts, | $W_g=2·745$; $W_p=0·4692$; $W_w=14·657$ | | | | | | | |

In relation to the material employed in these experiments and the results obtained therewith, the following is to be remarked. The ruthenium was prepared from the perfectly osmium-free so-called iron residues of the mint of St. Petersburg. For this purpose the gray powder was taken, which

TABLE 7.

| Elements. | Specific heat. $a$ | Atomic weight. $b$ | Atomic heat. $a \times b$ |
|---|---|---|---|
| Ruthenium, | 0·0611 | 52·0 | 3·18 |
| Calcium, | 0·1722 | 20·0 | 3·44 |
| “ | 0·1686 | 20·0 | 3·37 |
| Allotropic tin, | 0·0545 | 58·8 | 3·21 |
| Cast tin, | 0·0559 | 58·8 | 3·39 |
| Indium, | 0·0574 | 37·8 | 2·17 |
| “ | 0·0568 | 37·8 | 2·13 |

remains after the disintegration of this material with barium chloride in a stream of chlorine gas, and which gives by melting with potassic hydrate a copious yield of potassic ruthenate. The oxide thrown down from this salt by fractional precipitation with carbonic acid was converted into chloride with hydrochloric acid, the aqueous solution of this latter salt was precipitated with hydrogen gas, and the metal, in the state of lustrous scales, was ignited in a current of hydrogen to remove every trace of oxide. It proved on examination to be entirely free from the other platinum metals. The specific heat found therefor accords, as might be expected, with the previously accepted atomic weight.

The calcium was reduced by electrolysis from melted calcium chloride. It formed small pale golden-yellow globules with a high metallic luster, which take in the air, very rapidly, a grayish tarnish. Before enclosing in the glass envelope, they were shaved bright in an atmosphere of carbonic acid. Upon examination, it proved to be almost entirely pure. From the atomic heat thus found, it may be concluded that the previously accepted atomic weight $C_a=20$ is the correct one, and need not, as has become necessary with the atomic weights of the alkali metals, be halved.

Under allotropic tin is understood the singular modification of this metal, which appears to form from ordinary tin by long continued very low temperature. The specimen investigated came from the large mass, altered by the cold of an unusually long and severe winter, on which Fritzsche had observed this remarkable allotropy, first described by him. The mass consisted of an aggregate of small undeterminate angular rods loosely coherent in one direction, which crumbled by even slight pressure. This tin possesses, as I have convinced myself, a high degree of purity, contains no trace of antimony or arsenic, and dissolves completely in potassium trisulphid without leaving any basic metallic sulphids. The small rods of which it consists are not brittle but ductile like ordinary tin. The non-allotropic metal investigated was obtained by re-melting the allotropic variety. Both modifications lead to nearly the same specific results.

The indium employed showed itself to be entirely free from tin, cadmium and iron. Oxidized by nitric acid and evaporated with sulphuric acid, it left upon solution in alcohol, no trace of plumbic sulphate. 1·0592 grams of the metal dissolved without loss in nitric acid, gave after evaporation and ignition 1·2825 grams indic oxide. If the latter, according to the previous views, be considered as consisting of equal atoms, there results from this determination the value for the atom of indium, In=37·92, which number agrees very closely with the one determined by Winkler, In=37·81. This atomic weight, multiplied into the obtained specific heat $S_c$, gives, however, for the atomic heat of indium the value, $S_c$ In=2·13, which does not agree with the others.

The previously accepted hypothesis, that indic oxide is constituted according to the formula InO, appears therefore no longer tenable. If the atomic weight be accepted as once and a half so great, In=56·7, then will the atomic heat be, $S_c$In=3·23, nearly equal therefore to that of the other elements. The atomic weight 56·7 removes the anomaly, that indic oxide which was previously considered monacid, is, according to its entire deportment, analogous to that class of trin-acid bases, which forms no alums. For the previously accepted formulæ, given in column I of the following table 8, must therefore be substituted the ones in column II.

TABLE 8.

| | I. | II. |
|---|---|---|
| Black indious oxide, | InO ? | InO ? |
| Yellow indic oxide, | InO | $In_2O_3$ |
| Green indious-indic oxide, | $5InO, In_2O$ | $2InO, In_2O_3$ |
| Gray indous-indic oxide, | $4InO, In_2O$ | $3InO, 2In_2O_3$ |
| Hydrous indic oxide, | InO, ĦO | $In_2O_3$, 3ĦO |
| Indic sulphate, | $InO, SO_3$, 3ĦO | $In_2O_3, 3SO_3$, 9ĦO |
| Indic chloride, | InꞒl | $In_2$Ꞓ$l_3$ |
| Ammonium indic chloride, | 2N̵Ħ$_4$Ꞓl, 3InꞒl, 2ĦO | 2N̵Ħ$_4$Ꞓl, $In_2$Ꞓ$l_3$,2ĦO |

The ammonium-indic-chloride, prepared by R. G. Meyer, and cited in this scheme, possesses, according to the new formula, an analogous composition with ammonium rhodic chloride, which likewise contains 2 atoms of water. Whether or no the altered atomic weight finds comfirmation in an isomorphism in these salts I have been unable to investigate; I shall, however, return to this subject in a research, to be published later, on rubidium.

During this winter, for such experiments very unfavorable, I have been unable to make a trial of the instrument as to its fitness for the determination of the latent heats of melting. I

will only mention here that the latent heat of melting for water results already, with an accuracy which leaves nothing to be desired, from the experiments communicated in this work. According to table (2), one scale division of the calorimeter corresponds to $\frac{v s_e s_w}{s_w - s_e}$ grams of melted ice. The constant $W_w$, determined from equation (8), gives the number of scale divisions which correspond to one of the units of heat defined in the beginning of this treatise. One scale division of the colorimeter corresponds therefore to $\frac{1}{W_w}$ units of heat. If $l$ denotes the latent heat of melting for water, then will $\frac{1}{lW_w}$ give the weight of ice, expressed in grams, which corresponds to one scale division. There results, therefore, for $l$, the equation $l = \frac{s_w - s_e}{W_w s_e s_w v}$ or, according to equation (2), $l = \frac{1}{W_w p}$.
If the above found values

$$p = 0{\cdot}00085257 \qquad W_w = 14{\cdot}660 \qquad W_w = 14{\cdot}654$$

be substituted in the equation, there is obtained for the latent heat of melting of water $l$: 80·01
80·04
In the mean, 80·025

The value found by other observers by the method of mixture is, according to Regnault, 79·4; Person, 80·0; Hess, 80·3.

The heat of combustion of gases may be determined by means of the ice calorimeter with far greater accuracy than has been possible with any of the methods previously at our disposal. From the heat of combustion of hydrogen it follows with the aid of equation (4), that 10 cubic centimeters of this gas at 0° C. and 0·76 mercury pressure, would produce by their combustion with oxygen an oscillation of 453 scale divisions on the instrument employed in the experiments just described. It is therefore sufficient to burn a very small quantity of gas, and therefore one easily to be prepared in a state of purity, in the calorimeter, and to observe the oscillation on the scale thereby produced, in order to obtain directly the heat of combustion, expressed in units of heat, without any of the corrections, in part very uncertain, which were previously unavoidable.

## ART. LIV.—*On the Geology of the Delta, and the Mudlumps of the Passes of the Mississippi;* by EUG. W. HILGARD.

[Continued from page 246.]

### II. *The Lower Delta and the Mudlumps.*

A glance at the map shows that in descending the Mississippi from New Orleans, we find a narrow strip of land only ¾ to 3 miles wide, dividing the river from the waters of the Gulf; from the head of Oyster Bay opposite Pointe à la Hache (about half way between the city and the head of the Passes), down to the mouths. Such, at least, is the case on the left bank; on the right, the "neck" begins a few miles below Fort Jackson. Down to the forts, the aspect of the "Coast" is generally pretty much the same, where its original character has not been lost by cultivation or encroachment of the river. Nearest the river, and highest above water level, are the sandy "willow battures," where the willow, mingled with and occasionally replaced by the cottonwood, forms the predominant growth. Beyond lies a belt of woodland, timbered chiefly with live-oak, magnolia, and cottonwood, often deeply veiled with long-moss; this belt embraces the richest and most durable soils of the "Lower Coast," and is mostly occupied by magnificent plantations of sugar cane and orange orchards. Beyond these, loom in the distance the sombre-hued, moss-curtained denizens of the cypress swamp, their tops forming a level platform sharply defined against the horizon. Between the swamp and the water's edge, seaward, there usually intervenes a zone of reeds, with here and there a stunted cypress, bay, or candleberry bush, where the salt water has but slight access.

While such is the general order of succession of these belts of vegetation where they coëxist, either or both of the two middle ones may locally be absent. Such is always the case where the "neck" is very narrow, as happens below the forts. Thence to the mouths of the passes, the willow batture and the reed marsh alone, with few exceptions, form the barrier between the river and the sea; it is traversed by numerous small bayous, some of which are in great part the work of the duck-hunters that supply the New Orleans market, and whose pursuit leads them to penetrate the marsh for the purpose of reaching the favorite resorts of their game. These bayous increase in frequency as we descend, and in approaching the mouths of the passes, the intervals between them become smaller, until they gradually become sheets of water dividing islands; and finally, just inside the bar, we have the latter resolved into numerous individual "mudlumps," dotting the surface of the sea, on both sides of the main channel.

Sir Charles Lyell remarks (Principles of Geology, 10th ed., p. 448), that the phenomenon of the mudlumps is without parallel, so far as known, in the delta of any other river. The same remark might, I think, appply to two other peculiarities, viz: the protrusion of the long neck of land into the Gulf; and the fact that, after failing to send out any branch of importance for a hundred miles the great river suddenly divides at one point into three widely divergent branches, the middle one of which (the South Pass), forming the direct continuation of the channel, is the smallest, and has long ceased to be navigable. Evidently, a strong extraneous obstacle alone could turn aside the powerful current, and permanently resist its erosive and undermining action. And now, the channel which carries the main current (the Southwest Pass), faithful to the old tradition, is rapidly pushing out into the Gulf its narrow bands of reedy marsh, without a branch of any consequence in ten miles from the head of the Passes to the light-house.

A glance at the coast lines, as well as at the intricate ramifications characterizing the deltas of the Rhine, the Po, the Danube, the Ganges, or the Hoang-Ho; or the broad inlets forming the mouths of the rivers of South America, will show the uniqueness of the Mississippi mouths; the Nile and the Lena alone exhibiting a general form at all analogous, yet very distinct in detail. For the islands off the Lena mouths are not "mudlumps;" and the tongue of land separating Lake Menzaleh from the Damietta branch of the Nile, is a mere sand-bar, exhibiting no analogy save that of form, with the remarkable "necks" of the Mississippi Passes.

It would be fair to infer, à priori, that some connection exists between the exceptional phenomenon of the mudlumps, and the exceptional form of the delta; and that such is really the case, can hardly be doubted upon a candid investigation of the facts. So far from being an unusual phenomenon, *the mudlump-formation appears to constitute the normal mode of progression of the Mississippi mouths;* not only at the present time, but for many ages past; perhaps ever since the broad flood of the Terrace epoch subsided into the present Mississippi.

The characteristic features of the mudlumps have successively been described and discussed by Sidell,* Forshey,† Chase, Beauregard and Latimer,‡ Thomassy§ and Lyell.‖ Yet as the phenomena are nowhere described in their entirety, I will here, as briefly as possible, recapitulate the important points.

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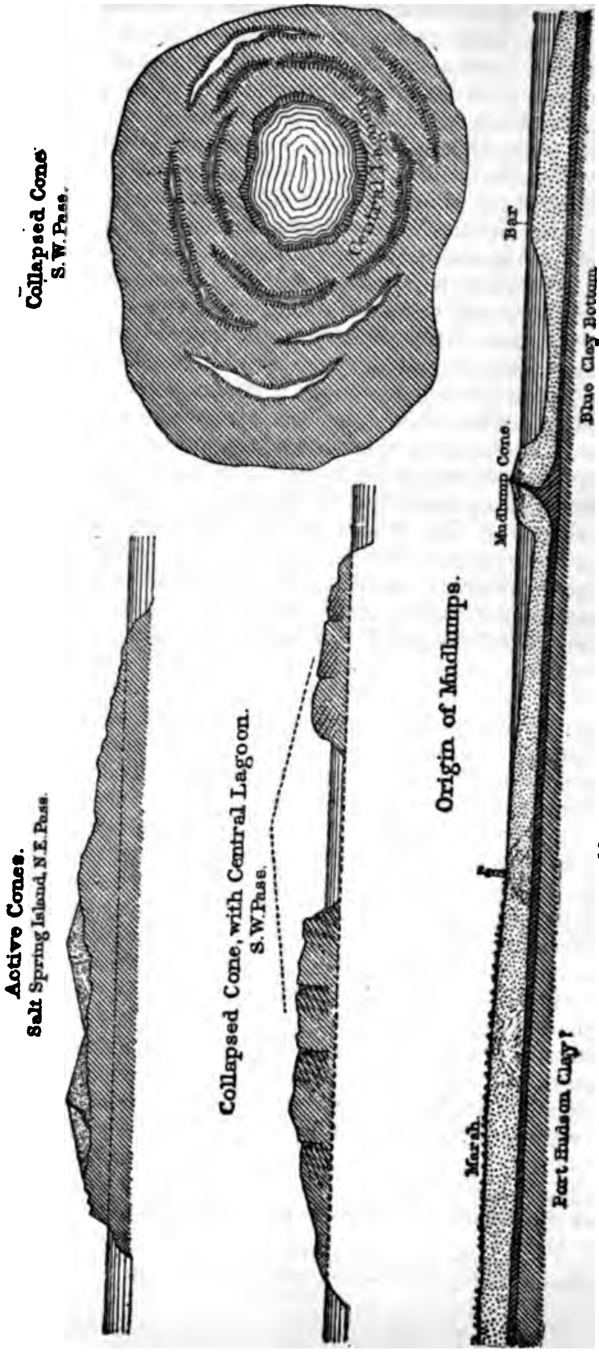
* Report to Capt. Talcott, 1839, in Humphreys and Abbott's Report, App. A.

† MS. Report, 1850.

‡ Report of the Board of Engineers for the Examination of the Mississippi; Congress. Doc. 1852–53.

§ Geologie Pratique de la Louisiane, 1860, Chap. VI.

‖ Principles of Geology, 10th edition, 1868; vol. 1, p. 449.



MUDLUMPS OF THE MISSISSIPPI DELTA.

The mudlumps originate in upheavals of the bottom, in the region lying between the extreme point of the mainland and the crest of the bar, at the main outlets of the passes. They all lie within a distance of from one to three miles from the axis of the main current, and nowhere extend into the bays intervening between the several active mouths. The pilots are under the impression that they form more frequently in the main channel than elsewhere ; but allowance must be made for the natural infrequency of their observations outside of the latter; so that only the more obvious and remarkable changes of the bottom, when occurring outside of their regular range, would be likely to come under their notice. *A priori*, it would seem probable that inasmuch as the resistance to the upheaving force, other things being equal, must be less in deep than in shallow water, the lumps would rise more frequently and more rapidly in the channel than elsewhere. On the other hand, the denuding force of the river current must greatly diminish the chances of any such upheaved mass appearing above the surface, or even becoming manifest by a diminution of depth, when progressing slowly. Weighing these considerations against each other, I think a balance remains in favor of the pilot's opinion ; the more as concurrent testimony goes to show that whenever the channel is changed, either by the accumulation of deposit or the interference of a mudlump upheaval, the old channel is promptly occupied by mudlumps *throughout* the abandoned portion.

As regards the rapidity of the upheaval, it appears to vary from an almost secular rate, to that of several feet in 24 hours. It has been rumored that lumps had been seen to rise visibly, and burst open like a bubble, but I have been unable to trace the statement to any reliable source, and it is discredited by the pilots. The most rapid rise of which I have obtained reliable information was witnessed by Capt. Andrews, of New Orleans. He states that a steamer having run aground about nightfall inside the bar, her bow being on a mudlump in about 2½ feet of water, he towed her off during the night, and in the morning found the imprint of her bow 18 to 24 inches above water, in the soft mud. Allowing for the possible maximum influence of tides in favor of the difference observed, the minimum rate of upheaval, according to these data, still amounts to one inch per hour. Nor is this the only case in which a rapid shallowing of the water has been observed as a consequence of the grounding of large vessels. This has usually been ascribed to the accumulation of deposit in the slack water so formed, and in many instances this may have been the true cause. But this explanation can hardly apply to the case detailed above, and it is reasonable to suppose that the shock of a grounding vessel may in many cases prove "the hair that breaks the camel's back," when acting upon a portion of bottom just about to yield to the upheaving force, and therefore in a state of unstable equilibrium. Future observations, however, will readily settle the question.

Of authentic observations illustrating ordinary rates of rising, I quote the following remarks of Mr. H. L. Marindin, U. S. Coast Survey, who in 1867, while engaged in the survey of the mouths, at my request paid considerable attention to the phenomena of the mudlumps, and made an interesting report to me on the subject, dated June 20th, and accompanied by specimens.

"Since the first examination of the mudlumps on Southwest Pass Bar, there have appeared numerous lumps in the vicinity of the main channel, whose appearance cannot be attributed to other causes than the upheaval of the bottom by some unknown agency; since tidal observations made during the month of April, May and part of June, show no material decrease in the height of water in the river, other than the daily ebb of the tide. In one instance, also, on this bar, it has been ascertained from surveys made at different times, that where in the month of April a channel with fifteen feet of water existed, there is now a lump, doubtless still forming, with only six feet of water on it at the highest stage."

Making allowance for a possible accumulation of deposit, the rate of rise cannot, in this instance, be estimated at less than two feet per month; which, so long as the lump remains under water, seems to be no unusual amount. When, however, the surface of the water is once reached, the rising becomes slower or ceases altogether, owing probably to the greater weight acquired by the material upon its emergence. At least, I have failed to find much above tide level, any material which did not bear distinct evidence of its having been formed, not by river alluvion, but by the action of the regular mudsprings; which, if not now active upon all the lumps, have demonstrably been instrumental in forming the great majority of the masses now above water level.

I do not know that any one has ever witnessed the first outburst of a mudspring on a newly risen lump; but we find them in all stages of progress, from the islet bearing its first tuft of rushes, to the active cones glistening in the sunshine, and from time to time, when an unusually large gas bubble rises, spattering the liquid mud (which usually flows in a quiet stream) all over the slopes; then the half-extinct cone, in whose crater a little pool of salt water is at long intervals agitated by a gas bubble; then the extinct and collapsed cone, surrounded by a circular moat and Somma-like ring-wall; next, the old lump of jagged outlines, whose disintegrated materials are rapidly yielding to the combined attack of rain, sunshine and waves, till something looking like a large stump of a tree is all that remains of an island of several acres; and finally the shoal, marked by dangerous rollers, whose surface, on a calm day, still exhibits the concentric markings corresponding to the several cones which originally built up the island.

I regret being unable at the present time, to present accurate sketches of these several stages of "the mudlumps' progress." I hope to do so hereafter, but for the present must confine myself to the approximate outline representations given in the plate, and a brief description of the several stages as observed by myself in 1857.

*Nascent Lumps.*—As regards the first, it is probable that a good many lumps never pass beyond that stage of development, for the reason that, so soon as the resistance is materially increased by the emergence of a portion above the surface of the water, the upheaving force seeks a vent elsewhere.

Either the mud or gas-spring breaks out beneath the water, and becomes perceptible only by the more or less regular and localized evolution of bubbles on the outskirts of the lumps; a very common phenomenon in the neighborhood, not only of new and active lumps, but also about extinct ones, which are in course of demolition by the waves. On the extensive sandy shoal off Stake Island, on the Southwest Pass, such subaqueous gas-springs may be observed in great numbers.—Or it may happen, that another portion of the bottom, now offering less resistance than the mudlump, will, in its turn, give way before the upheaving force, till the same degree of emersion is obtained, or a vent is opened.

I have been unable to ascertain how high any mudlumps can rise bodily above the water without the appearance of a vent. As much as three feet has been observed with certainty; but unless the fact that it is a new upheaval be historically known, it must be extremely difficult to ascertain it, unless, by actual access to the interior, it can be shown that its surface strata are old river deposits, which can readily be distinguished from those formed by mudlump vents. Yet these might, during the elevation of the lump, have been removed by the current. At all events, I have failed to find on the surface of any lump much above tide-water, anything like true river alluvium; the visible material being either such as is now formed by active vents, or, (as on the lower slopes), that which obviously results from the disintegration of the former, being altogether devoid of structure.

It is said that lumps sometimes sink from view again after bare emergence. I know of no authentic example, but it seems likely enough that upon the formation of a large vent elsewhere, such a thing might happen; especially if, as I think probable, mudsprings and mud-cones form *beneath*, as well as above the water.

*Active Cones.*—In the second stage, that characterized by the formation of the active eruptive cones, mudlumps offer an aspect so strikingly like that of the mud volcanoes of Tuscany, as to stagger the observer's geographical consciousness. The most striking example of the kind existed, at the time of my visit, off Pass à l'Outre, on the south (right) side of the channel. The island* is about an acre in extent, and besides the active vents (of which there are seven), we perceive on the southern portion the remnants of long extinct craters, in various degrees of advancement toward old age and degradation, and partially covered with vegetation.

The cones on the north or channel side, at a distance, present a glistening surface, and those possessing a central vent only are very regularly and smoothly conical. Of these there are four, the diameters of the bases ranging from eighteen to fifty feet, and their elevation from one to two and a half feet above the general level of the island; making the angle of the slope from 5° to 8° only, instead of 25° to 35°, as given in the published sketches. I have seen no undisturbed cone whose slope exceeded about 12°. The slope is, of course, essentially a function of the thickness and character of the mud; which in the present instance flows from the circular basin at the summit, 4 to 8 ins. in diameter, in a regular, creamy stream, interrupted occasionally only by a gas bubble; which, if the mud be thick, spatters it about to some extent. The mud-stream varies from 3 to 4 gallons per minute in the largest (eastern) cone, to a pint or two in the less active ones; sometimes, in running down the sides, it spreads over as much as ⅓ of the circumference, but usually forms a stream 4 to 8 inches wide, serpenting down the slope between banks formed by its own solidification, as does a lava stream. As these banks grow in height by drying, on the edge of the crater, they gradually compel the mud to rise higher before it can flow off; whereupon, after a while the column overflows at another point of the circumference, where the same play is then repeated. In the meantime, the previous mudstream has an opportunity of consolidating, drying more or less, and undergoing a variety of chemical changes dependent upon the character of the water and the duration of the exposure to the air, which manifest themselves in changes of color and consistency; by these the individual streams are distinctly defined from one another. Each one forms, of course, a more or less irregular portion of a conic surface, the cross section being more or less lenticular.

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* It was named Marindin's Lump by the crew of the U. S. Coast Survey Schr. Varina, and I shall allude to it under that designation.

There results, as may be supposed, a very peculiar structure or stratification, unlike anything usually seen outside of volcanic districts, unless, perhaps in the somewhat analogous case of the lee side of dunes. It may roughly be compared to the upper half of an onion. It is needless to say that, once seen, it cannot readily be mistaken for anything else; and its absence must be held as proof conclusive of an absence of genetic analogy.* The thickness of the layers rarely exceeds 1¼ inches; their colors vary from dark mouse-color and bluish gray, through dun and buff, to rust-color and red; the materials, from hard, plastic clay, always containing a great deal of fine silex and more or less coarse sand, to sandy clay and, rarely, clayey sand; the selvedges are frequently marked by iron rust and mica scales. Where, as is frequently the case, neighboring cones are confluent at their bases, the structure is of course complicated in a manner readily imagined.

As regards the gas evolved (which is in all cases inflammable), the small proportion its bulk bears to that of the mud simultaneously ejected (about $\frac{1}{25}$ to $\frac{1}{30}$ at Marindin's Lump), at once does away with the impression mostly entertained, that the gas bubbles bring up the mud with them. The latter comes up with a steady flow, evidently the result of static pressure, and is only from time to time agitated by a gas bubble, larger or smaller according as the mud is more or less consistent. We sometimes find, about extinct cones especially, lively gas springs in which the proportion of gas is considerably greater, than happens in any active cone that has come under my observation; but in that case, it is almost always accompanied only by *water*, as though its source were above the stratum which furnishes the mud. For, a glance at the river deposits forming around the lumps, at once shows that they are totally different from the fine, clayey material of which the cones are formed; nor is it credible that the mere passage of a current of water and gas through such deposits, or in fact, *any consolidated materials*, should produce such a perfect, creamy mixture as that ejected from these craters.

*Extinct Cones.*—Good examples of cones whose activity has nearly or quite ceased, may be seen off the Northeast Pass. Here the material is somewhat sandier and firmer than the mud ejected at Passe à l'Outre. While at the latter place it was difficult to reach the craters without being hopelessly bogged, they can readily be reached almost dry shod at the Northeast Pass. Here, also, the top layers were peeling off in large concave "flakes," from the effect of sun-cracks and drying; such a surface again overflowed by mud would add another singular feature to the structure of the cones, which may also be noticed in many sections of ancient ones.

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* Vide Thomassy's remarks on the Five Islands, etc., Géol. prat. de la Louisiane, chap. viii. With even less show of reason, a similar origin has repeatedly been claimed for the low circular mounds which dot a large part of western Louisiana. They consist exclusively of unstratified sandy materials, and are doubtless the result of animal activity—probably of the large ant.

The vent of a large cone in this region (see Plate) formed a basin about 8 inches diameter, containing a puddle of salt water covered with an iridescent ferruginous pellicle, disturbed at long intervals by small gas bubbles. Evidently, the resistance in the large cone, elevated about 10 feet above the water level, had become too great for the ejection of mud; in consequence whereof, a lively little cone was glistening and bubbling at a level several feet lower, near the foot of the old cone. *But the testimony of the pilots goes distinctly to show, that the active cones become more lively, and dormant cones resume their activity, at high stages of water in the river.* At the time of my visit, the water was at an unusually low stage.

*Collapsed Cones.*—The cones, especially the larger ones, appear to be unable to survive for any great length of time the cessation of activity. The change that occurs seems to be, in all cases, a sinking of the central portion, often to such an extent that its place becomes occupied by a pool or lagoon, surrounded by a circular rim whose strata incline *away* from the center at angles invariably much steeper than is found in any recent cones, from 20° to as much as 45°. Outside of this first rim there mostly appears a series of concentric crevasses, sometimes several feet in width and in depth; and the annular segments thus brought to a level by a subsidence, also exhibit the singular feature of a *steeper* inclination of the lines of deposition, than is found in any cones now forming. The seeming anomaly of this fact caused me to observe the phenomena closely; but I have been unable to find an exception to the rule; and I have been led to doubt whether in some cases, instead of true eruption cones, these collapsed areas and their surroundings may not be the remnants of the original upheaved "bubble." The objection to this interpretation is the character of the material, which, excepting in a few cases on the Southwest Pass, is altogether unlike the present river deposits, both in structure and composition.

A most perfect exemplification of a large central lagoon (100 feet by 75) surrounded by an elevated rim and several successive, concentric "moats," also in part filled with water, occurs on one of the numerous mudlumps S.W. of Stake Island, on the Southwest Pass (see Plate). The central portion does not always, however, sink out of sight; sometimes a conical mound is still observable, as the center of the more or less circular, concentric crevasses, which a close inspection shows to exist on almost all lumps not too far advanced towards decrepitude. Many islands exhibit several such centers and systems of crevasses, indicating, probably, the previous existence of cones, sometimes several hundred feet in diameter, greatly exceeding the largest now in a state of activity, both in diameter and original height.

*Degradation and Disappearance of Lumps.*—The direct action of the waves, unassisted by atmospheric agencies, produces but little effect upon the yielding, but tough and coherent material of the cones. The heaviest breakers and rollers spend their force in vain against the clay shoals which render most of the lumps so difficult of access. The unwary will often be tempted by the deceptive, rock-like aspect of this material, to jump into the shallow water and wade ashore; but a plunge knee-deep into the apparent solid will frequently reward his temerity. Yet so long as this mass, which shows plainly the peculiar, concentrically banded mudlump structure, remains constantly covered with water, the waves rolling over it produce but little impression.

Not so with the portion that projects above water, which is alternately exposed to rain, sunshine, and the wash of waves. Especially where the material is clayey, these agencies combined soon produce a change in which the structural as well as the paleontological characters of the original material are totally obliterated. A rain falling upon a fresh surface of the latter, causes it to swell; then, upon exposure to sunshine, it will contract into prismatic cleavage-forms. A slight rain, or the spray itself, will then cause the extreme surface to crumble into, and partially fill up, the cracks; when the swelling consequent upon a thorough wetting, by either rain or waves, will force them to open still more, while streamlets of fluid mud follow each retiring wave; which, perhaps, has thrown up, and left high and dry in the cracks, a dozen species of shells, entirely foreign to the mudlump mud itself. It is thus that the structureless, tough soil of the general surface, and of the beach of the mudlumps, is formed; and to it alone apply the descriptions given of the mass of the mudlumps, by Sidell, Thomassy and Lyell, as a "homogeneous, tenacious mud."

A frequent repetition of this process involves, of course, not only a rapid direct degradation of the lump, but it causes it to be cleft into fragments by rents gradually progressing from above downward, which rapidly increase the surface exposed to attack; and eventually, some large wave, in retiring, carries down with it a huge prismatic slice, leaving behind an almost vertical cliff. This is carried away in its turn, and thus, attacked from all sides, an island of considerable size, after passing through a variety of middle stages in which it strikingly resembles masses of trap or basalt, magnified into distant mountains by the peculiar optical delusion prevailing in the region,* is finally reduced to what, at a distance, appears to be the stump of a tree. At last, some storm sweeps away this last monument of the disappearing lump, and white-capped rollers alone mark, thereafter, the higher points of the mud-shoal.

I have best observed these phenomena of disintegration in every stage of progress, among the mudlumps off the Northeast Pass, where the fanciful, cliff-like forms, figured by Thomassy, Sidell, and Lyell, may be seen to perfection.

It is said that there are no mudlumps off South Pass or Grand Bayou; a statement which may require to be taken with a grain of allowance, but agrees with the general impression that the mouths discharging the largest amount of water, also exhibit mudlump activity on the most extensive scale.

The Southwest Pass is the main outlet at the present time; the area inside the bar is thickly studded with mudlumps, chiefly west of the channel; and as before stated, lumps have risen there repeatedly under the eyes of the pilots and survey parties. Yet there is not there, at the present time, a single *active* cone, so far as I am aware; although salt water and gas springs are of frequent occurrence, both on and around the islands. There is a marked difference between the river deposits as well as the mudlump materials of Passe à l'Outre and Southwest Pass, the latter being decidedly more sandy, and sand bars taking the place of the mud flats off the former. Whether this circumstance (the natural result of the greater swiftness of the current in Southwest Pass), is connected with the absence of active cones, it may be too early to discuss. Some very lively springs on a large mudlump off Stake Island on that Pass, in which the gas emitted is about equal in bulk to the water, rise in small basins excavated at the foot of a large cone which must have been 15 to 18 ft. high; but the material they bring up is so very sandy that the water runs off perfectly clear.†

*Mudlumps in the Marshes.*—I have before remarked, that at the present time, the upheaval of mudlumps on the passes, and subsequent silting up of the shallows between them (by river deposit, as well as by the degradation of the lumps themselves,) seems to be the normal mode of progression of the delta. The more advanced portions of the narrow bands of shore now forming along each one of the passes, are historically known to consist of mudlump-chains; and in the absence of any plausible presumption to the contrary, as well as of any parallel example in other rivers, it is reasonable to surmise, that not only the shores of the present passes, but also the neck, *at least* from Pointe à la Hache down, owes it formation and peculiar features to the same agencies.

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* Caused probably by a faint bluish haze, through which an island a quarter of a mile distant and 15 feet high, appears to be a wooded mountain with rocky escarpments, and at its foot a wide spreading city—which suddenly resolves itself into a row of grave white pelicans perched on the beach and taking wing at the approach of a boat.

† See analysis of the water of these springs, below; marked "S. W. Pass, I."

We have seen how rapidly and completely the joint action of the waves and atmospheric agencies accomplish the degradation of elevated lumps to the common level of the tide; and where the nature of the materials is such as to yield readily to these destructive influences, it would be unreasonable to look for vestiges of ancient lumps above that level. Such is the case, as before mentioned, on Northeast Pass and its branches.* But the sandier nature of the mudlump mass on Southwest Pass enables it to resist much longer, so that some of the larger and more elevated islands there seem destined to retain, more or less permanently, their present form. For the same reason, perhaps, the Southwest Pass furnishes the one prominent example of the existence of an active and characteristic mudlump, in the level marsh on the right of the channel, about five miles below the Head of the Passes, and seven above the mouth (light-house); distant 1½ miles from the river bank, and about one mile from the beach of West Bay. Double-headed Bayou, or one of its channels, passes within a few hundred yards of this lump; which is so difficult of access that it has been very rarely visited, though plainly visible from the hurricane deck of passing steamers, from which I have examined it with the telescope.

According to Thomassy,† the pilot Ben. Morgan, who has visited it, describes it as being "a regular truncated cone, 20 to 25 feet high and 300 in circumference, spouting at intervals from its summit masses of clayey and sandy mud, which overflows all around."

From the Pass, it now appears as a slightly irregular, conical hill, which, judging from the extent to which it projects above the highest reeds, is about 18 to 20 feet high at most. On its eastern side there is a second cone about half as high, with a very regular slope not exceeding 30°, while that of the large one is at least 45°. A whitish sheen which extends from the summit of the larger cone toward the smaller one, I interpret as a white salty efflorescence; but on the south slope of the smaller cone, the glittering of a flowing mudstream was unmistakable. Inasmuch as in Morgan's account of his visit the smaller cone is not mentioned, it is presumable that it has been formed since, by a lateral eruption; the old cone having, perhaps, reached the extreme limit of height to which mudlump force can raise its materials.

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* Col. Sidell mentions a mudlump cone, 18 feet high, on the north side of the Northeast Pass, in the marsh. It has probably succumbed since his visit, as in passing the spot I was unable to perceive any elevation, nor was it known to the pilots.

† Géol. prat. de la Louisiane, p. 56. I shall designate this cone as "Morgan's Lump."

The steep slopes of both the old and new cone are suggestive as to the influence of sandiness on that feature, and the explanation of the steep inclination of strata, observed chiefly on Southwest Pass.

It is my impression that another cone exists in the marsh about two miles south of these. It is almost screened from view by the reeds, but the telescope shows it to be distinctly conical. It does not seem to have attracted notice heretofore.

But if mudlump cones are scarce in the marshes, the same is not true with reference to the salt and gas springs, which are reported to be quite abundant by the hunters—the only men whose occupation leads them to "thread the pathless waste" of reedy marsh, otherwise seldom visited, save by surveying parties, and alligators. These springs are found on or around all mudlumps, of whatever age; even on the shoals left behind by disintegrated lumps, where they issue under water, sometimes altering perceptibly the character of the water in the immediate neighborhood. The Southwest lighthouse was originally built on a mudlump separated from the mainland by a bayou; this is now filled up, but salt springs still issue at several points in the marsh near the foot of the tower. It is obvious that the gradual accumulation of deposit is not likely to check lively springs, possessing sufficient head to rise, hydrostatically, above the level of the alluvium; though in many cases they may lose themselves in the sandy strata.

I have not had an opportunity of ascertaining whether or not salt springs are known to exist in the marshes near the Forts, and above. I fully expect to find, however, that they do exist, though, for obvious reasons, they will become less and less abundant as we ascend the river. At New Orleans, as already stated, gas and salt water are reached, and brought to the surface with considerable vehemence, by bores varying from 31 to 56 feet;* and I have no difficulty in believing in the correctness of the impression made upon Col. Sidell, that the foundations of the New Orleans customhouse were located upon a mudlump.† That such obstinate resistance as that of the "Head of the Passes" to denudation can hardly be attributed to a mass of river deposit, I have already intimated. A large mudlump mass has, probably, first caused the deflection.

[To be continued.]

* See above, p. 245.

† Lyell's Principles of Geol., 10th ed., p. 552.

## ART. LV.—*On the existence of the (so-called) compound Ammonium Amalgams;* by the late CHARLES M. WETHERILL, PH.D., M.D.

THE discoverer of methylamine did not succeed in forming a compound analogous to the ammonium amalgam, whether by the reaction of methyl ammonium chlorid with potassium amalgam, or by the influence of the galvanic current. This experiment, with negative results of Wurtz, is quoted in nearly all of the descriptions of the compound ammoniums.

In a series of experiments (this Journal, II, vol. xl, Sept., 1865) upon the formation and nature of the ammonium amalgam, by which it was demonstrated that this body is merely a metallic froth, I succeeded in forming the so-called amalgam of methyl ammonium. This body was found to be of a nature essentially similar to that of the ammonium amalgam, but of less turgescence. The salt used was the methyl ammonium oxalate, which was compared in this reaction with the ammonium oxalate. MM. Pfeil and Leffman (this Journal, II, vol. xlii, p. 72) repeated these experiments and confirmed the results, employing the tri-methyl ammonium chlorid. They also extended the reaction with sodium amalgam to the chlorohydrates of aniline, coniine, morphine and quinine and to the acetate of rosaniline; but without forming amalgams, hydrogen gas being evolved copiously without swelling.

H. Landolt (VI supplement, Annalen der Ch. u. Pharm., p. 346, "Ueber das ammonium amalgam") states in a foot-note, that he had repeated the experiment with tri-methylamine chlorid and sodium amalgam, and found "that the turgescence of the mercury takes place only when the preparation contains ammonium chlorid; the pure compound gives no amalgam.

This rendered necessary a repetition of my experiment upon the compound ammonium amalgam, as I had not myself tested the salts employed with respect to their purity. The former experiments were performed with a pure methyl ammonium oxalate, for which I am indebted to the kindness of M. Carey Lea, Esq., who gave me some prepared by his new method, being the same described by him in this Journal, vol. xxxiii, p. 366.

In the present experiments I prepared a fresh portion of the methyl ammonium oxalate by Lea's process, viz: by the action of aqua ammonia upon methyl nitrate. The two liquids were placed aside in a stoppered bottle for ten days, by which time the ether had disappeared. The distillate of this liquid over caustic potassa was exactly neutralized by oxalic acid and evaporated to crystallization. After removing the ammonium oxalate. the mother water was evaporated to dryness and boiled with 95 per cent alcohol; the hot filtrate on cooling yielded nacreous scales of methyl ammonium oxalate. The mother water of these crystals, by concentration, furnished an additional quantity a little darker in color. By filtering the crystals and washing them with 95 per cent alcohol by the aid of the Bunsen filter pump, they were completely freed from the dark mother water in which they formed. As the quantity of salt at my disposal was not more than a gram, fearing to reduce it by a recrystallization, I first tested the effect of a solution of the crystals upon sodium amalgam, and then converted a portion of each cup to methyl ammonium oxalate in which the Pt was determined. All which remained of the oxalate was recrystallized from a hot solution of alcohol and ether and experimented with, as in the former case. The crystals appeared to the naked eye to be prisms, but the microscope demonstrated them to be feathery needles polarizing light. They were very electric when warm, and possessed the property of felting together when pressed by the finger. They yielded golden-yellow crystalline scales or plates when converted into the Pt salt This salt is much more soluble than the corresponding ammonium salt, and crystallizes again from its solution in golden yellow hexagonal and triangular scales, being part of the octahedron and its replacements. The following are the results of the different analyses, from which it may be perceived that the methyl ammonium oxalate is perfectly pure, and that, as stated by M. Carey Lea, the first crystallization of the oxalate is pure.

I noted with respect to the Pt salt that some crystallizations furnished scales of a reddish tinge, but which gave the same percentage of platinum as the golden-yellow scales. The small quantity of substance at disposal for the analysis required very careful weighing to ¼ of a milligram.

*Analysis of methylam. chloroplatinates from methylam. oxalates.*

| | Grms. taken. | Grms. Pt. | Per cent Pt.* |
|---|---|---|---|
| First cryst: darker oxalate, | 0·4155 | 0·172 | 41·40 |
| Repeat, | 0·43975 | 0·18325 | 41·67 |
| First cryst: lighter oxalate, | 0·345 | 0·1435 | 41·59 |
| Ditto recrystallized, | 0·13675 | 0·05675 | 41·50 |
| Chloroplatinate from mother-water of the last chloroplatinate, | 0·0655 | 0·027 | 41·30 |
| Mean of all the analyses, | | | 41·49 |
| Wurtz's analysis, | | | 41·40 |
| Theoretical per cent, | | | 41·59 |
| Ditto for ammonium salt, | | | 44·29 |

These different specimens of methyl ammonium oxalate, dissolved in water, gave similar results when shaken with sodium amalgam. To ascertain this fact, a portion of fluid sodium amalgam of the size of a pea was placed in a small test tube (¼ inch diam.), and the solution of ammonium oxalate added, the swelling was observed both with and without shaking, in the cold and with warming. The same experiment was performed with the different specimens of methyl ammonium oxalate. The latter all swelled to from 8 to 10 times the original volume, which was very much less than the turgescence of the ammonium salt. With the compound ammonium salt, the swelling was not apparent until the tube was shaken and heat facilitated the reaction; this may be the reason that it has been hitherto overlooked. The methyl ammonium amalgam presented the same buttery appearance as the ammonium amalgam, and a knife blade placed in it was amalgamated. When the lump was pressed between two plates of glass, as in the method I proposed, to prove the frothy nature of the so-called ammonium amalgam, myriads of gas bubbles were apparent; when these were pressed out the amalgam was at once restored to the condition of mercury. In all cases shaking the tube appeared to be necessary in order to develop the swelling to its *fullest* extent. In performing this act, care was taken not to convey the ammonium salt to the methyl ammonium tube by the finger.

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* Eq. Pt 1·98.

In the former experiments it was not deemed necessary to form the compound ammonium amalgam by the aid of the battery; in the present this result was attained in the following manner, (vide op. cit., Exp. 15).

A piece of filter paper was placed upon a glass plate, then saturated with a strong solution of the recrystallized methyl ammonium oxalate. A globule of mercury of the size of a small pea was placed upon the paper with the negative pole of 20 cells Bunsen in contact with it; the positive pole touching the paper. The globule swelled slightly, presented a buttery appearance, attached itself to and amalgamated the blade of a penknife which was in contact with the negative pole, and upon being pressed under a glass plate *showed innumerable gas bubbles in its substance*, (in fact was a metallic froth) which emitted an ammoniacal odor.

It results from these experiments that the compound ammonias (at least that which I have examined) may form the so-called amalgam. I defer the bearing which this fact has upon the so-called ammonium and hydrogenium amalgam to a paper of some experiments which will shortly be published.

# SCIENTIFIC INTELLIGENCE.

## I. CHEMISTRY AND PHYSICS.

1. *On the spectrum of the Aurora Borealis.*—**ZÖLLNER** has called attention to the fact already remarked by other observers that the lines in the spectrum of the aurora borealis do not coincide with those of any known element, and has endeavored to give a rational explanation of the want of coincidence without assuming the presence of unknown elements in the earth's atmosphere. If the lines in question are really of electrical nature and are produced by the ignition of highly rarefied gases, the ignition must take place at so low a temperature that it would be impossible to observe the lines in Geissler's tubes. Hence Zöllner thinks that the spectrum of the aurora does not correspond with any known spectrum of the atmospheric gases, because it is a spectrum of a different order which cannot at present be produced artificially. If, at a given temperature, $A\lambda$ and $E\lambda$ represent respectively the values of the absorptive and emissive powers for the wave length $\lambda$ for the unit of thickness and density, $m$ and $\sigma$ the thickness and density of the luminous layer of gas, we have, according to Zöllner, for the brightness E of the part of the spectrum corresponding to $\lambda$, the expression

$$E = [1 - (1 - A\lambda)^{m\sigma}]\frac{E\lambda}{A\lambda}.$$

For a given gas and given temperature this expression depends only on the value of the product $m\,\sigma$. In a Geissler's tube filled with rarefied air, take the diameter of the narrow part of the tube as $1^{mm}$, and regard this as the unit of thickness $m$, and take as the unit of density the density of the enclosed air corresponding to a temperature of 0° and pressure of $1^{mm}$ of mercury. If now we ignite the air in the tube by an inductorium, then at a constant temperature the spectrum would remain qualitatively and quantitatively unchanged if the diameter of the narrow tube were increased from $1^{mm}$ to $1000^{mm}$, and if at the same time the pressure on the gas were diminished to $\frac{1}{1000}^{mm}$.

Wüllner found that in the case of nitrogen the spectrum became sufficiently luminous for spectroscopic examination only when the pressure was diminished to $46^{mm}$, while in the case of oxygen the necessary diminution was to 28 to $30^{mm}$. If we assume that in Wüllner's apparatus the current passing through a tube $1^{mm}$ in thickness and under a pressure of $50^{mm}$ produces light enough to observe the atmospheric spectrum, we may compare with this the thicknesses of the luminous layers which occur in the case of the aurora, which are of course far greater, and, at a distance from the zenith, to be estimated in miles. If we take the thickness of such a layer as only 1 kilometer, then at the same temperature as in the last case, the density would have to be only the one-millionth of that of the air enclosed in the tube, and therefore exert a pressure of only $0{\cdot}00005^{mm}$ at 0° C., in order that the spectrum of the air in the tube should completely correspond with that of the aurora. The question then arises—is it permissible to assume the existence of such low degrees of pressure in the regions of our atmosphere in which the aurora is developed? If we suppose the aurora to be at a height of ten geographical miles, the temperature of the atmosphere at the surface of the earth being 0° and the barometric pressure $760^{mm}$, the pressure will be $0{\cdot}078^{mm}$; at a height of twenty miles, $0{\cdot}00001^{mm}$. A layer of ignited air $1^{m}$ in thickness would therefore, at a height of ten miles, be equivalent to a pressure of $78^{mm}$, and at a height of twenty miles, to a pressure of $0{\cdot}01^{mm}$ in a Geissler's tube, in order at the same temperature to give a spectrum as bright as that of the aurora. But as the thickness of the layer of ignited air must be reckoned by kilometers instead of meters, we should have, even at a height of ten miles, so high a value for the equivalent pressure in a Geissler's tube—$78^{m}$ of mercury for a layer 1 kilometer in thickness—that the most powerful induction apparatus could not overcome the resistance of the air. From this it follows that the quantity of particles of ignited air in a Geissler's tube is probably extremely small when compared with the *active* quantity in the case of the aurora. Since, however, the spectrum of a gas in such a tube must have at least the brightness of the auroral spectrum to admit of spectroscopic analysis, it follows that the emissive power of the particles of gas ignited in the tube must be much greater than that of the ignited gaseous particles in the case of the aurora. Such a difference can be produced *only* by differences in temperature. If, therefore, the light of the aurora depends on ignited particles of our atmosphere, the temperature at which the ignition takes place must be much lower than that at which the same gases can be ignited by electricity in Geissler's tubes. From these considerations it appears that all the gas-spectra of the different orders which we can artificially produce belong in general only to high temperatures, since the relatively greater brightness with less quantities of ignited matter renders a greater emissive power necessary, and this can be produced only by a higher temperature. Conversely as in the case of the aurora, corona, zodiacal light, &c., a great number of active luminous particles must be assumed to exist, it follows that the temperature of the ignited gases must be relatively low.—*Pogg. Ann.*, cxli, 574. W. G.

2. *Synthesis of coniin.*—By the action of an alcoholic solution of ammonia upon butyric aldehyd, at a temperature not exceeding 100° C., Schiff obtained two bases, the formation of which may be represented by the following equation:

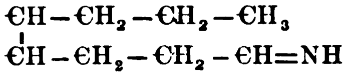
$$C_{16}H_{29}NO = 4C_4H_8O + NH_3 - 3OH_2$$
Tetrabutyraldin.

$$C_8H_{17}NO = 2C_4H_8O + NH_3 - OH_2$$
Dibutyraldin.

By the distillation of dibutyraldin, besides oily substances and bases of a higher order of condensation, a strong alkaline base is obtained which possesses all the properties of coniin, the formation of which may be represented by the equation:

$$\underset{\text{Dibutyraldin.}}{\text{Ꞓ}_8H_{17}N\Theta}=\Theta H_2+\underset{\text{Coniin.}}{\text{Ꞓ}_8H_{15}N}$$

According to this synthesis, the structural formula of coniin would be:



$$\begin{array}{l}\text{Ꞓ}H-\text{Ꞓ}H_2-\text{Ꞓ}H_2-\text{Ꞓ}H_3\\ \mid\\ \text{Ꞓ}H-\text{Ꞓ}H_2-\text{Ꞓ}H_2-\text{Ꞓ}H{=}NH\end{array}$$

The author promises further details.—*Berichte der Deutschen chem. Gesellschaft, Jahrgang* iii, p. 946. W. G.

3. *On the basicity of uranic oxide, molybdic, boric and nitrous acids.*—Schultz-Sellack has found that the normal sulphates of antimony and bismuth may be easily prepared in an anhydrous state, by dissolving the oxide in moderately concentrated sulphuric acid and evaporating. Both salts crystallize in fine needles; they are respectively $Sb_2(\text{Ꞩ}\Theta_4)_3$ and $Bi_2(\text{Ꞩ}\Theta_4)_3$. On the other hand, uranic oxide, molybdic, boric and nitrous acids form analogous compounds, the formulas of which are:

$$(\text{Ʉ}\Theta)_2\text{Ꞩ}\Theta_4,\quad (HU\Theta)S\Theta_4,\quad (\text{Ʉ}\Theta)_2\text{Ꞩ}\Theta_4+\text{Ꞩ}\Theta_3$$

$$(\text{M̶}\Theta)_2\text{Ꞩ}\Theta_4,$$

$$(HN\Theta)\text{Ꞩ}\Theta_4,\quad (N\Theta)_2\text{Ꞩ}\Theta_4+\text{Ꞩ}\Theta_3$$

$$(HB\Theta)_2\text{Ꞩ}\Theta_4+\text{Ꞩ}\Theta_3.$$

The uranic and molybdic salts are crystalline; the boric salt is a thick fluid or glassy mass, which could not be obtained of constant composition. The analogy between some of the above salts and potassic dichromate is easily seen, when the formulas are written $(\text{Ʉ}\Theta)_2\text{Ꞩ}_2\Theta_7$, $(N\Theta)_2\text{Ꞩ}_2\Theta_7$, $(HB\Theta)_2\text{Ꞩ}_2\Theta_7$. In a subsequent paper the author describes several other compounds of analogous constitution, which may be derived from the acid $H_2\text{Ꞩ}_2\Theta_7$, and some of which are new. The salt $KH\text{Ꞩ}_2\Theta_7$ may be obtained crystallized by dissolving $K_2\text{Ꞩ}_2\Theta_7$ in fuming sulphuric acid. It crystallizes in prisms which fuse at 168° C. The silver and barium salts have respectively the formulas $Ag_2\text{Ꞩ}_2\Theta_7$ and $Ba\text{Ꞩ}_2\Theta_7$. The salts of arsenous and antimonous oxide, $As_2(\text{Ꞩ}\Theta_4)_3+\text{Ꞩ}\Theta_3$ and $\text{Ꞩ}b_2(\text{Ꞩ}\Theta_4)_3+\text{Ꞩ}\Theta_3$, or, as we should prefer to write them, $As_2\Theta(\text{Ꞩ}_2\Theta_7)_2$ and $\text{Ꞩ}b_2\Theta(\text{Ꞩ}_2\Theta_7)_2$, are both crystalline and easily decomposed by water.—*Berichte der Deutschen chem. Gesellschaft*, iv *Jahrgang*, p. 12 and 114. W. G.

4. *Researches on Vanadium.*—Roscoe has communicated to the Royal Society a further instalment of his very valuable and interesting researches on vanadium. Metallic vanadium absorbs hydrogen in quantities which vary according to the state of division of the chloride from which the metal is prepared ($VCl_2$) and of the metallic powder itself. When the compound is exposed to dry air it takes up oxygen, forming water and an oxide which has nearly the formula $V_2\Theta$.

*Vanadic oxytribromide*, $V\Theta Br_3$, is formed by passing the vapor of bromine over vanadic trioxide, $V_2\Theta_3$, heated to redness. It is

-red transparent liquid, which under a pressure of $100^{mm}$ of ry volatilizes between 130° C. and 136° C. Its density at s 2·9673.

*ıadic oxydibromide*, $V\Theta Br_2$, is formed when the oxytribro- s heated above 180° C. It is a very deliquescent yellowish- solid resembling ochre. Heated in air it loses bromine and the pentoxide.

*ıadic tribromide*, $VBr_3$, is a grayish-black opaque amorphous ıate formed by passing dry bromine vapor over vanadic ni- ıeated to redness. It loses bromine on exposure to the air, very deliquescent.

*ıadates.*—Roscoe finds that there are three classes of vana- which may be termed metavanadates, pyrovanadates and anadates. Sodic orthovanadate is formed by fusing vana- :ntoxide with sodic carbonate, dissolving in water and pre- ing with alcohol. Its formula is $V\Theta_4Na_3+16\Theta H_2$. It is ıely unstable, being readily decomposed according to the on:

$$2(V\Theta_4Na_3)+\Theta H_2=V_2\Theta_7Na_4+2NaH\Theta.$$

orthovanadates are mostly insoluble compounds. Pyro- ıte of sodium has the formula $V_2\Theta_7Na_4+18\Theta H_2$, and is lline and easily soluble in water. When heated with car- dioxide it yields sodic carbonate and metavanadate:

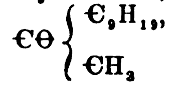
$$V_2\Theta_7Na_4+\text{Ͼ}\Theta_2=2V\Theta_3Na+\text{Ͼ}\Theta_3Na_2.$$

author describes various salts of vanadic acid, and points e fact that the order of stability is at ordinary temperatures, ıetavanadates, second, pyrovanadates, and third, orthovana- which is exactly the reverse of the order in the case of the hates.—*Journal of Chem. Society*, vol. ix, p. 23. W. G.

*)n a new platinum chloride.*—Sidney A. Norton has given ıminary notice of a new chloride of platinum, discovered by ı Prof. Kolbe's laboratory. If one molecule of platinic chlo- e mixed in aqueous solution with two molecules of silver ni- the yellow compound of platinous chloride with silver chloride , AgCl, described by A. Cammeille (C. R., lxiii, 553) is n down. The yellowish-red liquid above contains no silver; ıporation, it evolves acid vapors abundantly, and when suffi- ʏ concentrated, deposits on standing over sulphuric acid, ful large well-formed red crystals, which appear to be :linic in form. These crystals contain only platinum and ne—in the proportions of platinic chloride—and water. They stinguishable from the ordinary platinic chloride by being :liquescent in the air—even slightly efflorescing in dry air— y the fact that their aqueous solution is not precipitable by nium chloride, until after long standing or on the application t. Norton suggests that this compound may be a hydrated ic-oxide hydrochlorate, $Pt\Theta_2$, 4HCl, aq. or a chlor-platinic hydrochlorate $(PtCl_2)O$, 2HCl, aq. isomeric with the ordinary ted chloride. Investigations now in progress will settle the

point for this as well as for other similar metallic compounds.—*J. pr. Ch.*, II, ii, 469, Dec. 1870. G. F. B.

6. *Synthesis of Oil of Rue.*—Gorup-Besanez and Grimm have lately succeeded in forming oil of rue synthetically. Starting from the fact first suggested by Hallwachs, and confirmed by Harbordt, that this oil is a mixed ketone of the formula



$$\text{ꞒƟ}\begin{cases}\text{Ꞓ}_9\text{H}_{19},\\ \text{ꞒH}_3\end{cases}$$

since it is oxidized with difficulty and yields capric acid, they distilled together equal molecules of pure dry calcium caprate—prepared from a Hungarian wine-fusel-oil—and calcium acetate. The mixture melts, swells up, blackens, and evolves at first a fluid smelling like acetone, but afterward an oil which solidifies in the neck of the retort. By fractioning this distillate, three products were obtained: one boiling below 200°; another boiling between 210° and 245°; and a solid body, caprinon, boiling above 300°. The second fraction was purified by conversion into the double salt of ammonium sulphite, crystallizing from alcohol, and decomposing by sodium carbonate; a colorless, strongly refracting oil rose to the surface, which when dried, distilled completely between 223° and 224° and had at 17·5° C. a specific gravity of 0·8295. Commercial oil of rue, treated in the same manner, afforded a liquid distilling between 224 and 225·5° and having at 18·7° C. a specific gravity of 0·8281. Analysis of the ammonium double sulphite prepared from both, and of the pure oil both artificial and natural, gave the same result. Hence oil of rue consists essentially of methyl-caprinol or nonyl-methyl ketone.—*Ber. Berl. Chem. Ges.*, iii, 518, June, 1870. G. F. B.

7. *On the action of Chlorine upon Aldehyde. A new Chloral.*—With the intention of utilizing a waste product coming from the manufacture of aldehyde and consisting of alcohol and aldehyde essentially, Krämer and Pinner undertook its treatment with chlorine to see if it could not be converted into chloral. A flask containing 100 grams was placed in a freezing mixture and a slow stream of dry chlorine passed into it for 24 hours. The mass became thick and nearly doubled in volume. Subjected to distillation the greater portion passed over between 160° and 180°. This was purified by agitation with sulphuric acid and redistilled. It passed over between 163° and 165°, forming a colorless oily liquid, having a strong attraction for water, so that when mixed with it, heat was evolved and the mixture solidified to a crystalline mass. The same phenomena were noticed on mixing it with alcohol. Analysis gave numbers approaching closely both crotonyl-chloral and butyl-chloral; the authors are inclined to consider it the former, since Kekulé has shown that by removing a molecule of water from two of aldehyde, crotonyl aldehyde results. In this case, the chlorine first replaces hydrogen in the aldehyde, forming chlorhydric acid, which acid acts to withdraw water and thus condense the unattacked aldehyde to crotonyl aldehyde, in which the further replacements of hydrogen by chlorine occur. This new

chloral unites readily with water, as above stated, forming a solid which when crystallized from water, forms brilliant white silky plates which obstinately retain an excess of water. This crotonyl-chloral hydrate is easily soluble in alcohol and crystallizes therefrom unchanged. Its vapors are very irritating to mucous surfaces, attacking the eyes energetically. It melts at 78°. Treatment with potassium hydrate did not decompose it as it does common chloral, into allyl-chloroform and formic acid. A heavy oily fluid of peculiar odor collected at the bottom of the vessel, having the formula $Є_3H_2Cl_2$. Upon oxidation with fuming nitric acid, it is converted readily into trichlorcrotonic acid $Є_4H_3Cl_3Θ_2$. —*Ber. Berl. Chem. Ges.*, iii, 383, May, 1870. G. F. B.

8. *On the composition of the oil of the Palm-seed.*—Palm-oil is an orange-colored fat obtained from a palm tree growing on the west coast of Africa and called by botanists *Avoira elais* (Syn. *Elais guinensis*). The natives prepare it exclusively from the fruit-pulp, the hard stone in the interior being by them thrown away. Within a few years, however, these nuts have been brought to Europe and there expressed, yielding a more or less white oil, according to the care exercised. The seeds yield from 35 to 45 per cent of oil. A preliminary examination having shown that the fat of the palm-nut differed from palm-oil, OUDEMANS subjected it to investigation. One and a half kilograms was saponified with potash, and the fatty acids were separated from the soap with dilute sulphuric acid. After cooling they were removed and washed with cold water. The larger part was distilled with water in a tinned-copper flask, the distillate (about 4 liters) carefully collected and examined. It consisted of a clear liquid smelling like a volatile fatty acid (A) with a small quantity of a solid fatty acid (B) swimming upon it. The liquid was saturated with barium hydrate, by which a small quantity of a difficultly soluble barium salt (C) separated. The liquid was filtered and evaporated to 50 cc. On cooling, about a centigram of a crystalline barium salt separated, which proved to be barium caprylate. The mother liquor afforded barium caproate. The barium salt (C) was added to the fatty acid (B) also treated with barium hydrate, the whole boiled repeatedly with water and the crystalline deposits collected and recrystallized. On analysis they proved to be barium caprate. The caprylic, caproic, and capric acids thus obtained were not more than ¼ of one per cent of the fat. The residue in the copper flask was dissolved in aqueous alcohol, cooled to crystallize the fatty acids from oleic acid, the crystalline mass dissolved in alcohol and fractionally precipitated with barium acetate. In this way, the fat of the palm-nut was shown to be composed of glycerides of lauric, palmitic, stearic and oleic acids, with traces of tricaprin, tricaprylin, and tricaproin (perhaps also trimyristin). Quantitatively, Oudemans finds the triolein to be about 27 per cent, tristearin 31·7 and tri-laurin 41·3 per cent, of the fat of the palm-nut.—*J. pr. Ch.*, II, ii, 393, Dec. 1870. G. F. B.

## II. GEOLOGY AND NATURAL HISTORY.

1. *On the Mineralogy of Eozoon Canadense.*—Dr. ROBERT HOFFMANN of Prague has submitted to chemical and mineralogical investigation the Eozoon Canadense, found at Raspenau in Bohemia, (*Jour. für prakt. Chemie*, May, 1869). He describes the Eozoon mass as having a superficial resemblance to that of Canada, appearing in waved or concentric bands, oval in form, or else in irregular acervuline aggregates. In the oval banded portion the shell of the Eozoon, a nearly pure, finely granular calcite, can be separated from the mineral representing the sarcode, which is described by Hoffmann as a cast of the soft parts of the Eozoon, formed through infiltration of watery solution either during the growth or immediately after the death of the animal. It is a peculiar silicate, fine-grained, grayish-white and somewhat translucent, the analysis of which is given below, (I). Associated with this is a finely granular dolomite, destitute of any traces of organic structure, which sometimes appears to have served as a center or point of attachment to the growing Eozoon. In other cases, however, broken fragments of older Eozoon had served as nuclei, and become surrounded with a fresh growth. These materials, which constitute what Hoffmann has described as the Eozoon reef, are associated with two other silicated minerals. One of these, allied to fahlunite, has a specific gravity of 2·687, is grayish-brown or greenish-black in color, dull, or with a somewhat fatty luster, and nearly opaque. This substance, whose analysis is given under II, forms nearly parallel streaks in the central parts of the Eozoon reef, and moreover surrounds it, intersecting and wrapping around the Eozoon mass in multiplied layers, a line or more in thickness, which are interlaminated with a light green mineral, transparent, with a somewhat vitreous luster, and a density of 2·56. It is a hydrous silicate (III), allied to picrosmine and is more or less penetrated by magnesite.

| | I. | II. | III. |
|---|---|---|---|
| Silica, | 53·388 | 36·425 | 52·677 |
| Alumina, | 10·521 | 32·944 | 1·260 |
| Ferrous oxide, | 10·091 | 20·140 | 1·011 |
| Magnesia, | 11·127 | ..... | 30·414 |
| Lime, | 1·048 | ·678 | ..... |
| Potash, | 1·378 | 2·721* | 1·900 |
| Soda, | 2·094 | ..... | ·233 |
| Water, | 10·991 | 7·092 | 11·865 |
| | 100·638 | 100·000 | 99·360 |

The band of Eozoon rocks at Raspenau lies between silicated schistose rocks beneath, and overlying beds of granular limestone, some of them grayish white, and others blackish from an admixture of carbonaceous matter. One of these gave to analysis 1·100 of carbon, 2·332 of insoluble matter, and 4·708 of carbonate of magnesia, the remainder being carbonate of lime. The composition of the Eozoon shell is given under IV, that of the dolomite under V, and that of the magnesite which penetrates the silicate, III, under VI.

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* Akalies determined by loss; some soda was present.

| | IV. | V. | VI. |
|---|---|---|---|
| Carbonate of lime, | 97·711 | 53·815 | 5·581 |
| Carbonate of magnesia, | traces | 40·420 | 84·651 |
| Carbonate of iron, | 1·660 | ..... | 1·001 |
| Alumina, | ·629 | ..... | 8·767 |
| Insoluble, | (phosph. traces) | 1·260 | ..... |
| | 100·000 | 95·495 | 100·000 |

T. S. H.

2. *On a Mineral Silicate injecting Paleozoic Crinoids;* by T. Sterry Hunt, F.R.S.—A Silurian limestone from near Woodstock, New Brunswick, lately examined microscopically by Dr. Dawson, was found by him to consist almost wholly of comminuted organic remains, including fragments of trilobites, gasteropods, brachiopods, and joints of small encrinal stems and plates; the whole cemented by calcareous spar in a manner similar to many organic limestones. He observed, however, that the pores of the crinoidal remains were injected by a peculiar mineral, readily distinguishable in thin transparent sections, or on surfaces which had been exposed to the action of an acid, which dissolves the carbonate of lime and places in relief the injecting mineral. The minute structure thus revealed is precisely similar to that of recent crinoids studied by Carpenter, and will soon be described and figured by Dawson. Decalcified specimens exhibit a congeries of curved, branching and anastomosing cylindrical rods of the replacing mineral, sometimes forming a complex network, which, under the microscope, resemble the coralloidal forms of aragonite known as *flos ferri*, and present a frosted crystalline surface. The same mineral, as observed by Dr. Dawson, occasionally occupies larger interstices among the fragments, and was evidently deposited before the calcareous spar which cements the whole mass.

When this limestone is dissolved in dilute hydrochloric acid, the residue, washed by decantation, equals from five to six per cent of the weight of the mass, and is seen under a microscope to consist entirely of the casts composed of the mineral just noticed, mixed with about one-fourth of coarse siliceous sand. This matter is pale grayish-green in color, but when calcined becomes of a bright reddish-brown, without change of form. Heated in a close tube it gives off water, and becomes much darker in color. It is partially attacked by strong hydrochloric acid, which takes up much protoxide of iron; but is readily and completely decomposed by hot concentrated sulphuric acid, leaving a skeleton of silica which, by a dilute solution of soda, is readily separated from the intermingled grains, more or less rounded, of colorless vitreous quartz. The analysis of 1·187 grams, effected by decomposing it in the way just mentioned, yielded silica ·3290, alumina ·2440, protoxide of iron ·1593, magnesia ·0360, potash ·0140, soda ·0042, water ·0584, insoluble quartz ·3420=1·1869. This calculated for 100·00 parts of the silicate gives as follows; silica 38·93, alumina 28·88, protoxide of iron 18·86, magnesia 4·25, potash 1·69, soda 0·48, water 6·91. The analysis of another portion of ·526 grams by fusion with an alkaline carbonate gave, by calculation for the silicate, 18·80 of protoxide of iron, and amounts of alumina and combined silica closely agreeing with those found above. The oxygen ratio for $\ddot{\mathrm{Si}}$, $\not{\mathrm{R}}$, $\dot{\mathrm{R}}$, $\dot{\mathrm{H}}$, is as 20·77 : 13·46 : 6·29 : 6·14, or nearly as 3 : 2 : 1 : 1. This mineral approaches closely in composition to jollyte, but differs from it in containing a portion of alkalies, and but one half as much water. In these respects it agrees closely with a silicate found by Robert Hoffmann with the Laurentian Eozoon of Raspenau, (Jour. für prakt. Chem., May, 1869, and this volume, page 378). This latter is compared by Hoffmann to fahlunite, to which species also jollyte is allied in physical characters as well as in composition (Dana's Mineralogy, page 493.) Under the names of fahlunite, pinite, etc., is included a great class of hydrated silicates, which, from their imperfectly crystalline condition, have generally been regarded, like serpentine, as the results of the alteration of other silicates. It is, however, difficult to admit that silicates found in the condition described by Hoffmann, and still more the present mineral, which injects the pores of paleozoic crinoids, can be any other than original depositions, allied in the mode of their formation to the serpentine, pyroxene and other minerals which fill the chambers and canals of the Laurentian Eozoon, and to the glauconite which occurs in a similar manner in Tertiary and recent shells. The limestone from Woodstock, apart from the insoluble matters just described, is very pure, yielding only 1·80 p. c. of alumina and iron-oxide, and magnesia equal to 1·35 p. c. of carbonate.

Montreal, March 10, 1871.

3. *On native amorphous Mercuric Sulphide.*—G. E. **Moore** has recently examined a specimen of black mercury-ore collected in Lake county, California, by Professor Whitney. It occurs as a coating on the sides of cracks and crevices in a peculiar quartzose gangue, and is accompanied by crystallized and massive iron and copper pyrites, and very minute cochineal-red crystals of cinnabar. Its physical properties are thus given:—Entirely without structure or cleavage. Fracture semi-conchoidal to uneven, fracture-surfaces brilliant. Very brittle when struck or bent, yet tough when cut. Rubbed in an agate mortar the powder becomes a solid mass, taking a high polish and a metallic luster like graphite. Color grayish-black. Luster metallic. Streak on porcelain pure black. Cut surfaces brilliant. Hardness about 3 on Mohs's scale, somewhat greater than cinnabar, though difficult to estimate exactly on account of its brittleness. Specific gravity 7·701 to 7·748; somewhat different in different specimens on account of admixed cinnabar. Before the blowpipe it behaves like cinnabar. In the closed tube, it sublimes completely, with the exception of a trifling residue of quartz and iron oxide. The black sublimate yields a

cinnabar-red powder when care is taken that the upper part of the tube is heated to near the subliming point of the cinnabar. A qualitative analysis showed mercury and sulphur, with small quantities of iron and silica. Quantitatively examined it yielded as follows:—Sulphur 13·82, mercury 85·79, iron 0·39, quartz 0·25. Whence its composition is

$HgS$, 98·92; $FeS_2$, 0·83; Quartz, 0·25 = 100·00.

Experiments to determine the chemical cause of the difference in properties between this mineral and cinnabar, resulted negatively. Moore concludes that the mineral in question is completely identical with the black amorphous mercuric sulphide of the laboratory, and proposes for it the name Metacinnabarite.—*J. pr. Ch.*, II, ii, 319, Nov. 1870. G. F. B.

4. *Freieslebenite and Diaphorite.*—Von Zepharovich has shown (Sitz. Acad. Wiss. Wien, 1871), that Freieslebenite includes two species of similar composition ($Ag_4Pb_3Sb_4S_{11}$) but different crystallization. He retains the original name for the *monoclinic* species and gives the name diaphorite to the *orthorhombic.* The former is from Freiberg and Hiendelaencina in Spain, and has for the ratio of the inclined diagonal, the orthodiagonal and the vertical axis 1 : 0·5871 : 0·9277; and the inclination of the last is 87° 46′; sp. gr.=6·35. The diaphorite is from Przibram and Freiberg, and has for the ratio of the diagonals and vertical axis 1 : 0·4919 : 0·7344; and sp. gr.=5·90.

5. *On the Eocene beds of Utah;* by T. A. Conrad. (From the author.)—I am indebted to Prof. Cope for an opportunity to examine some Eocene fossil shells, collected at Aspen station, and at Quaking Asp Ridge, east of Bear river, Utah, at an elevation of 7,100 feet. These fossils were taken from the rock in which they were imbedded, by Lucius C. Ricksecker, engineer on the Pacific Railroad. They are imbedded in indurated clay, and suggest the probability that they lived in a river rather than a lake, especially as there is a genus of Cyrenidæ (*Veloritina* Meek) as well as one of Corbulidæ (*Anisorhynchus* Conrad) which lived apparently in company with Unionidæ and Melaniidæ. These fossils are especially interesting in consequence of the light they cast on the condition of the globe in the earliest Eocene period. This group immediately overlies the Cretaceous strata, and corresponds with the Lignite beds at the base of the Paris Eocene and those of Provence described by Matheron, which is the first supracretaceous group of strata known to occur in Europe, and according to Matheron has a "colossal development;" and of his first stage of Lignite, he remarks that where the lower bed is in contact with the chalk, it shows fragments of marine shells not easily determined, but he recognizes *Ostrea* and *Cardium.* This is probably the broken up surface of the Cretaceous formation which emerged above the sea, a condition naturally following the agitation of the waters of a retiring ocean. Upon this bed follows five stages of Tertiary Lignite of fresh water origin, the lower beds containing *Unio Toulouzanii* (*Loxopleurus* Meek), *Cyrena globosa*, and *C. Fesrusssaci.* This mixture of fresh and brackish water genera corresponds with

the lowest beds of the Eocene in North America. This exact correspondence in stratigraphical position between the European and American older Eocene, as well as in the hydrography and topography of the respective continents at that period, is elucidated by the affinity of the fossils as regards their peculiar generic characters. Thus the genus *Loxopleurus* Meek originated and died out with the older Eocene fauna. This was also the case with *Veloritina* Meek, a genus closely allied to if not identical with a genus which Deshayes regards as *Cyrena*, but arranges in a separate section (*C. Trigones*). He describes ten species of the Paris basin and Matheron one from Provence (*C. globosa*). This genus is unknown in later Eocene strata. A gasteropod of the family Melaniidæ cannot be distinguished generically from one in the Lignite beds of Provence, named *Melanopsis armata* by Matheron. This is the *Tiara* (*Pyrgulifera*) *humerosa* Meek. It is a well characterized genus, very distinct from *Tiara* and more nearly related to *Melanopsis* Ferrus. It is also limited to the lower Eocene, and was probably an estuary or brackish water shell, although its nearest living form is *Varena crenocarina*, which inhabits the Pedro Branca river, Bahia. *Loxopleurus* Meek is related on one side to *Castalia* and on the other to *Trigonia*, which latter genus apparently became extinct in the Cretaceous era, for it is unknown in Tertiary formations, and reappears in the actual seas with very different external characters and I think without genetic descent from the fossil species.

The marine equivalent of this lower Eocene formation is probably to be found in the division B, of Mr. Gabb's Cretaceous fossils of California.

The hydrography of this early Tertiary era may be imagined from the foregoing statement to have been a river system analogous to that of Brazil at the present time. The presence of vast numbers of estuary shells forbids us to suppose that the group inhabited lakes rather than rivers, which rose in not greatly elevated hills, for mountains, except as isolated peaks, had hardly been developed at this period, when the great basin of Utah was submerged, and the Mississippi valley and its rivers were not yet formed, but the general drainage was into the Pacific ocean. There was then a system of great rivers and a densely wooded country eminently fitted for land animals, whose remains I have no doubt are to be found, if they have not been already obtained. The elevation of this vast region to any considerable height took place in the first stage of the Eocene era, and if we are surprised at the great extent of such brackish water rivers, we have only to glance at a similar river system 2,200 miles up the Amazon. By the rise of the Cretaceous formation, this condition of the country was formed, and as no transition beds are known, the advent of new genera and species so different from what had lived before is an unexplained phenomenon in the geological history of the globe.

So far in Europe, I believe, no authentic account has been published of any fossiliferous beds between the lower Eocene and the Cretaceous strata, that would indicate a transition period to have intervened. And so in Utah, Idado and Wyoming, the same remarkable condition is apparent, as it is in the Eastern States, in England, France, Spain, India, on the banks of the Nile and in South America, which proves that the revolution which closed the Cretaceous era was co-extensive with the globe and destroyed the life of the period.

6. *Coal Plants of the Illinois Geological Survey, 4th Volume.* —Mr. Lesquereux's chapter on coal plants, in the fourth volume of the reports of the Geological Survey of Illinois, embraces descriptions of 78 new species. It also includes remarks upon numerous instructive specimens of previously described species (40 of which had not before been recognized in America), and is, as a whole, the most valuable contribution to the history of our American coal plants which has appeared since the publication of the Pennsylvania Report in 1858.

At the close of the descriptive part of the report (p. 471), the author gives the list of the species of plants thus far identified from the Illinois coal field, showing their geographical distribution. This, however, is not to be considered an estimate of their *actual* distribution, as the author states, because of the very extensive explorations at one or two points, and the almost entire neglect of large portions of the field which would probably, if explored, yield fully as rich collections.

The report closes with a pretty full discussion of the "Mode of Preservation of Vegetable Remains in our American Coal-measures," of the "Affinities of the Illinois Coal-flora," and of the "Stratigraphical and Geographical Distribution of the Coal-flora."

We have here mention of the fact that plants are sometimes found in good preservation in the solid coal, as well as in the disintegrated form of mineral charcoal which often occurs between the layers of the denser coal. "This [former] case is especially observable in a kind of hard laminated flint coal, obtained in Mercer county by Mr. H. A. Green [of the Survey], which bears on the horizontal surface of its crystalline lamellæ, however thin they may be cut, the outline and nervation of leaves and branches of ferns and other vegetables of the coal; and these are so distinctly marked that the most delicate parts are as easily identified as those of plants preserved in shales. The great abundance of these remains shows that the whole mass of this coal, which is true coal and burns freely, is a compound of them.

In shales, the leaves of ferns and other plants are sometimes finely preserved in the form of extremely thin layers of coal; while, in other cases, the carbonaceous matter has nearly disappeared, leaving barely enough to show the outlines of the fossil. In still other cases, we find larger or smaller fragments of the cuticle of plants, not completely altered to coal, of a reddish-brown color, and retaining considerable elasticity. "The shales, according to the amount of vegetable matter mixed in them, and the depth at which they have been formed under water [?], are of a more or less dark color; whitish or yellowish, when of fresh water origin, and with few remains of plants; black and generally more homogeneous when formed in deep water, and having, for a larger proportion of their compound, broken remains of organized beings."

The author is not satisfied to refer to ordinary concretion or segregation, the formation of the ironstone nodules from Mazon Creek, which have yielded so many ferns, insects, crustaceans, etc. He says:—"from their position, their form and size, varying according to the nature and outline of the bodies which they contain, the nodules of Mazon Creek rather seem to be the work of infusoria or *Bacillaria* concentrating molecules of iron around some centers, as now happens in the formation of bog iron ore, or in other deposits in springs or pools whose waters contain a solution of iron. This supposition appears confirmed by the manner in which the bodies in concretions have been preserved and selected for preservation. Though generally merely fragments, their integrity is complete; and yet some of them are of very soft texture. The pinnæ or leaflets of ferns are always found in them in a flattened position, their axis or rachis extending through the center of the elongated nodule, with the divisions on both sides; the surface of the pinnules slightly swollen, as when in their living state, is marked by recognizable hairs or fruit dots, with distinct veins and vainlets; and their appendages, like the scales, are seen in the various modifications which they present in the living specimens. * * The small organs of plants appear, then, in a better state of preservation than in the shales. With small animals like crustaceans, scorpions, insects of a fleshy and very delicate texture, the preservation of form is still more remarkable. They are found entombed in the middle of the nodules just as if they were in life, or as if they had been transformed into stone while still living. The fruits or nutlets are not flattened. * * Peculiar species of plants and animals seem to have been selected as the nuclei of these nodules," certain forms which are abundant in them being scarce or entirely wanting, so far as observed, among the fossils of the shaly portion of the same bed at Morris five miles off, and *vice versa.* F. H. B.

[We propose to continue this notice in another number.]

7. *The Bone Cave of Eastern Pennsylvania* (p. 335).—Recent letters from Mr. WHEATLEY state that the cave is constantly making new disclosures. He writes:

Of Megalonyx, I have 30 to 40 teeth and 3 in the *jaw;* and parts of 17 individuals of the sloth tribe. Prof. Cope has this day read a paper before the American Philosophical Society describing the following species of vertebrates: *Megalonyx splenodon* Cope, *M. tortulus* C., *M. toxodon* C., *M. Wheatleyi* C., *M. dissimilis* Leidy; *Mylodon Harlani* Owen; *Arvicola hiatidens* C., *A. sigmodus* C., *A. pinetorum* LeConte, *A. involuta* C., *A. speothen* C.; *Hesperomys ?leucopus* Raf.; *Jaculus ?Hudsonius* Temm.; *Erethizon cloacinus* C.; *Sciurus calycinus* C., *S.* ——*?; Lepus sylvaticus* Bachm.; *Scalops? ——?; Vespertilio? ——?; Tapirus Americanus* Brisson, *T. Haysii* Leidy; *Mastodon Americanus* Cuv.; *Bos ——?; Equus ——?, E. ——?; Ursus pristinus* Leidy; *Felis ——?; F. ——?; Canis ——?; Crotalus ——?, Coluber ——, C. ——?; Tropidonotus ——?; Cistudo ——?; Emys ——?; Rana ——?,* *Meleagris* —— ?, *Scolopax* —— ?; not identified 3. The whole number is 41 species; 6 of them Edentates, 12 Rodents, 1 Insectivore, 1 Chiropter, 8 Ungulates, 4 Carnivores?, 2 Birds, 6 Reptiles, and 1 Batrachian. Dr. G. H. Horn has examined the insects and has recognized among them the following species: *Cychrus Wheatleyi*, *C. minor; Cymindis aurora; Chlœnius punctatissimus; Pterostichus lævigatus*, *Pt. longipennis; Dicœlus alutaceus; Aphodius scutellaris*, *A. micans; Phanæus antiquus; Copris punctulatus; Saprinus? ebeninus.* He also observes that there are several others which he does not venture to name.

8. *On Fossil Vertebrates of Caves on the Island of Anguilla, W. I.;* by Dr. Cope, (Proc. Amer. Phil. Soc., Nov. 18, 1870) — These vertebrates include a crocodilian, two birds, one deer and five rodents. Three of the rodents were of gigantic size, and included, besides two species of Chinchilla already described (loc. cit., 1869, 193) a third, still larger, the *Loxomylus latidens* Cope. The bones of the deer indicated a species little over half the size of the Chinchilla.

9. *Report on the Progress of the State Geological Survey of Michigan;* presented Nov. 22, 1870, by Alexander Winchell, Director. 64 pp. 8vo. Lansing, 1871. Published by authority of the State.—The survey of Michigan now in progress was ordered by the State in 1869, when $8,000 per annum were appropriated for the purpose. The appropriation was to be divided equally between the surveys of the Upper and Lower Peninsula, and in this way the work has now been carried forward for two years. Toward the survey of the Marquette district, Major T. B. Brooks has been engaged, and for the copper region, Professor R. Pumpelly.

The pamphlet issued is only a brief statement of the objects of the survey and of some of its results. Among the facts mentioned under the head of General Geology are the following.

The water-lime group of the Lower Helderberg rocks occurs in the State near the west end of Lake Erie in Monroe Co., and also on Mackinac Island, and the mainland of the Upper Peninsula to the west. The Huron group of rocks, as Prof. Winchell has before announced, is referred by him to the Portage and Chemung, and the Marshall group to the Subcarboniferous.

Among the western and northwestern borders of the Lower Peninsula, the *boulder drift* is underlaid by "vast horizontal beds of bluish and pinkish clays, nearly free from boulders, and diversified with occasional seams of lignitic and soil-like material," which rest on the scratched rocks. The boulder deposits are distributed through beds of obliquely laminated sands and clays, and on these rest the lakes and peat bogs of the State. In these upper deposits are found remains of the elephant, mastodon, and Castoroides.

Prof. Winchell also mentions the discovery of *an ancient outlet of Lake Superior* through the valley of Au Train and Whitefish rivers into Little Bay de Nocquet and Green Bay of Lake Michigan; it is a deep valley bordered with high bluffs, mostly limestone at bottom, across between Lake Superior and Little Bay de

Nocquet. He adds, "It may easily be that the elevation (of the ancient valley), is just such as to justify the project of a ship canal across the divide, with the view of shortening the voyage" between the ports of the two lakes. This outlet lies in the prolongation of the axis of Green Bay, "and recalls opinions formerly entertained, based solely on topographical data, that Green Bay was once prolonged through Lakes Winnebago and Horicon in Wisconsin." This elongate hydrographical basin conforms in its longer axis with the direction of the glacial striæ and boulder transportation.

10. *Note on Limestone containing Petroleum in Nova Scotia;* by D. HONEYMAN, (Edit. Corr., dated Halifax, Nova Scotia, Provincial Museum, March 28, 1871).—We have recently received a quantity of Lower Carboniferous limestone from Kempt in this province, having numerous cells with small crystals of calcareous spar and petroleum. When the limestone is broken, you almost invariably find the cells with the petroleum, the latter having a honey-like appearance. The limestone is in connection with gypsum.

11. *New York State Cabinet of Natural History:* 20th Report. 1867. 448 pp. roy. 8vo, with numerous plates and wood-cuts.—This beautiful volume is a reprint of the State Cabinet Report for 1867, or rather it is from a revised edition of it. It is the most extended and valuable of the series, and well deserved reproduction in a better form. A notice of it appeared in this Journal in vol. xlvi, 1868. It contains Hall's admirable paper on the Graptolites, illustrated with many wood-cuts and four plates; descriptions of a very large number of fossils of the Niagara group, with figures of the species on 21 excellent plates; also several shorter papers. Some of the latter are controversial, and have already been the subject of remark in this Journal.

12. *Saurocephalus of Harlan.*—Dr. COPE observes (Proc. Phil. Soc., Nov. 18), that the genus *Saurocephalus*, instituted on Cretaceous fishes, instead of being Acanthopterygian, is Malacopterygian, and between the Salmonidæ and Amiidæ. The spines and rays have been regarded by some authors as of the Cestraciont genus *Ptychodus.*

13. *Geology of Ohio.*—We understand from Prof. Newberry, the director of the Geological Survey of Ohio, that another Annual Report is ready for the press. If the plans of Dr. Newberry are sustained and carried out by the State, Ohio will not be behind Illinois in the character of its final Report.

14. *Note on Asaphus platycephalus, by* J. D. DANA.—The closing remark in my paper on page 321 will have to be canceled, if the species, there referred to *Asaphus platycephalus*, is identical with the *Asaphus platycephalus* (*A.* (*Isotelus*) *gigas*), of Trenton, the latter (as Mr. Billings writes the author) often occurring in New York rolled into a ball.

15. *On the Earthquake at Oahu, Hawaiian Islands, on Feb.* 19; by Professor W. D. ALEXANDER. (From a letter to J. D. Dana, dated Oahu College, Feb. 28, 1871).—We have a letter upon this earthquake, by Professor Alexander, of Honolulu, which will appear in our next.

16. *Claparède on Marine Bryozoa.*—In the first number of vol. xxi of Siebold u. Kölliker's Zeitschrift, Claparède, who with the exception of Nitzsche is the only writer who has studied the Bryozoa since the publication of the capital papers of Smitt, gives us most interesting contributions to their history. While on the main points he completely agrees with the views taken by Smitt of the polymorphism of the species, their mode of budding and general embryonic development, yet in some points not satisfactorily determined by Smitt, such as the relations of the various cells (zoœcia) to one another, the nature of Smitt's "mörka kroppar," dark bodies, and "fett kroppar," he has new observations differing somewhat from those of Smitt. The most interesting facts are those concerning a sort of retrograde development, a resorption of the digestive cavity in the older cells, the gradual disappearance of the lophophore, resulting in cells usually considered as dead, but in reality having latent life, and where alone the fatty bodies of Smitt, which play such an important part in the embryology of Bryozoa, are developed. These cells apparently pass through stages identical with those produced by budding at the youngest extremity of the colony, with the difference that in one case the cell is immature, while in the other it is fully developed. The resorption is frequently accompanied by peculiar changes in these cells, and is confined to the older portions of the Bryozoan colony in which the lateral connection between the cells for exchange of fluids between the cells provided with digestive cavities and those cells containing latent life, is very strikingly shown, thus forming a complete circulation between the most distant parts of the colony. He also confirms the nature of the colonial nervous system, first traced by Fritz Müller, and shows its existence among the Chilostomata, where it had only been traced by Smitt before. Claparède closes this interesting paper by giving us the complete development of Bugula, with larger, more accurate, and at the same time more intelligible figures than we have had of the early development of any one species of marine Bryozoa thus far. He has, however, not been able to decide positively the nature of the ova, said in one case to owe their origin to a sexual process, and in the other cases to point to the existence of parthenogenesis among Bryozoa, under certain circumstances. Claparède has not confirmed the observations of Schneider on the development of Membranipora, but from what Nitzsche has observed of the early stages of Bugula, he appears to have seen the same retrograde development in the youngest stages of its larva which Schneider observed in Cyphonantes during its development into Membranipora. A. AG.

17. *Ceratodus, its place in the system of Fishes.*—The *Ceratodus Forsteri* of Krefft (Proc. Zool Soc., 1870, 221), a fish from Australia supposed to be congeneric with the *Ceratodus* of Agassiz from the Devonian, first made known by Hon. WM. FOSTER three years since, has been recently studied by Dr. Günther, and an extended memoir on it has been presented by him to the Royal Society. We take the following facts from an abstract of this memoir

in the Ann. Mag. Nat. Hist., IV, vii, 222. The skeleton is of the type so well known from the descriptions of *Lepidosiren* and *Protopterus* by Owen, Bischoff and Hyrtl. The teeth are much like those of *Protopterus*, *Psammodus*, *Dipterus*, etc., in microscopic structure, and identical with those of the fossil *Ceratodus*—confirming thereby Mr. Krefft's reference of the fish to the last mentioned genus. Dr. Günther names a second Australian species *Ceratodus miolepis.*

Messrs. A. Hancock and T. Atthey have an article on the subject in the same volume of the Ann. Mag. Nat. Hist., p. 190, in which they present the conclusion that, while the fish referred to is nearest to *Lepidosiren*, it is probably more distinct in genus from the Devonian *Ceratodus*, than from *Ctenodus* and *Dipterus*, especially the former (these two genera for reasons stated being kept separate). *Ceratodus*, they observe, "is probably a true Cartilaginous fish, and consequently a Selachian or Placoid," and the fact that only its dental plates are known, nothing of the bony supports of the same having been found, is urged as sustaining this view.

18. *Coccoliths.*—*Coccoliths*, calcareous disk-shaped organisms, regarded by Huxley at first as a unicellular plant (alga), and afterward the secretions of his Bathybius (analogous to the siliceous spicula of a sponge) have been recently examined by H. J. Carter (Ann. Mag. Nat. Hist., IV, vii, 184), and found to be what they were first pronounced. Carter finds them very abundant in shallow waters as well as profound depths. After mentioning the results of chemical examinations in which he found a "granular protoplasmic disk remaining after the action of acetic acid, he adds:

> "Thus, still more convinced that I had a unicellular Alga under examination, and taking a portion of the little arborescent fronds of *Melobesia calcarea* ("the chalk-*Melobesia*"), which, in about ten fathoms, occurs here in accumulated beds or banks of probably miles, certainly acres, in extent, I pulverized a portion for examination, and observed several fragments whose cells, but for their polygonal arrangement, presented very much the appearance of the coccolith in their concentric lines, transparent area. and central granule, together with the absence of blue color under the iodine test.
>
> Lastly, considering that the coccolith is so abundant in the Laminarian zone here, and so voraciously fed upon by the Echinodermata and Ascidiæ, also that it is so nearly allied in composition, structure, and habit to *Melobesia calcarea*, that it chiefly forms the bed of the Atlantic ocean, and that it is found fossilized in the chalk; I cannot help inferring that it is a vegetable organism which contributes chiefly to form the calcareous deposits of the present day in many parts, and has done so in the formation of calcareous ones of the past, at all events that of the chalk."

He names two species *Melobesia unicellularis*, from the Atlantic ocean bottom, and also the Laminarian zone on the South coast of Devon, and *M. discus*, from the Atlantic ocean, each stated as "accumulating in beds." The cell in each is described as calcareous, discoidal or discal, transparent, convexo-concave, consisting of two convexo-concave disks, one a little larger than the other and receiving the smaller one in its concavity, and enclosing a granular protoplasmic disk, with a central transparent area. The first is obtusely elliptical, and about $\frac{1}{1700}$th in. long and

$\frac{1}{12000}$th in. thick; the second is circular and about $\frac{1}{2300}$th in. in diameter. The latter is not found in the Laminarian zone.

*Coccospheres* of Huxley are of two kinds, and are made up of frustules of the above species, the two different kinds never occurring mixed in one coccosphere. Carter regards the coccospheres as the "*sporangia* of the two species of *Melobesia*." Besides the two distinct kinds of coccospheres, there are also the "loose type" of coccospheres of Huxley. This, Mr. Carter has not seen, but he conceives that they may represent more developed form of the sporangium or coccosphere, perhaps undergoing dehiscence.

The coccoliths must furnish food for the lower animals over the bottom of the deep sea, as they do for those along its borders.

19. *Transactions of the Connecticut Academy of Arts and Sciences*, Vol. I, Part 2. 376 pp. 8vo, with 7 lithographic plates. New Haven, Feb., 1867 to March, 1871.—This work has been much delayed by a fire, by which most of it was destroyed in 1869. It is entirely occupied by the "Notes on the Radiata in the Museum of Yale College," by A. E. Verrill. Under this head there are nine distinct articles: No. 1, Descriptions of New Star-fishes from New Zealand; No. 2, Notes on the Echinoderms of Panama and west coast of America, with Descriptions of new Genera and Species; No. 3, On the Geographical Distribution of Echinoderms of the west coast of America, with a Comparison of the Tropical Echinoderm-Faunæ of the east and west coasts of America; No. 4, Notice of the Corals and Echinoderms collected by Prof. C. F. Hartt at the Abrolhos Reefs, Province of Bahia, Brazil, 1867; No. 5, Notice of a collection of Echinoderms from La Paz, Lower Cal., with Description of a new Genus; No. 6, Review of the Corals and Polyps of the west coast of America (six plates); No. 7, On the Geographical Distribution of the Polyps of the west coast of America; No. 8, Additional Observations on Echinoderms, chiefly from the Pacific coast of America; No. 9, On the Echinoderm-Fauna of the Gulf of California and Cape St. Lucas. All these articles, except the three last, have been noticed in this Journal, from time to time, when they have been published as separate pamphlets.

Nos. 6 and 7 have also been issued under one cover, forming a pamphlet of 193 pages, with six plates. The early parts of No. 6 were noticed in this Journal last year. In the portion describing the Madreporaria several changes have been introduced in the classification, of which the most important is the institution of a new sub-order (*Oculinacea*) to include *Stylasteridæ* Gray (emend.), *Oculinidæ*, *Pocilliporidæ* Gray, *Stylophoridæ*, *? Stylinidæ*, *Astrangidæ*, *Caryophyllidæ*. Several changes are made in the limits and characters of the families and genera: *Madreporidæ* is made (as by Prof. J. D. Dana) to include both *Madrepora* and *Montipora; Astrangidæ* is extended so as to include *Cladocora* and its allies; the *Caryophyllidæ* of Edw. and Haime are divided into two families, the second division, *Turbinolidæ*, corresponding nearly with *Turbinolinæ* E. and H.; *Agaricidæ* Gray (emend.) is adopted instead of *Lophoseridæ*. The relations of *Pocillipora* are discussed anew, and the author's view, previously expressed in other works,* that *Pocillipora* is a true Polyp, and not at all allied to *Millepora* and other Hydroid corals, is again insisted upon, and the relations of the *Pocilliporidæ* to certain fossil corals is discussed. "Its affinities with numerous extinct genera having the same tabulate structure, is a matter requiring a great amount of careful investigation. From *Favositidæ*, as a whole, it differs in having an abundant cœnenchyma. *Favosites* differs also in having perforate walls, and doubtless ought to be separated, at least as a distinct family, which has, perhaps, closer relations with *Madreporacea*."† A number of new corals are also described and, in the Addenda, some additional new *Gorgonidæ*.

In No. 7, lists are given of the species found in each of the faunal divisions of the west coast, with their range, etc., and in some cases special local lists are added. In the Panamian Fauna 104 species occur, none of which have been found beyond the limits of that zoölogical province. The plates are chiefly devoted to the Gorgonacea, and two of them illustrate the spicula of many species.

20. *Second and Third Annual Reports of the Trustees of the Peabody Academy of Science for* 1869 *and* 1870, Salem, Mass., received March, 1871.—This report contains the services on the occasion of dedication of the Museum, with the address of the President of the Academy and remarks by others; the Proceedings of the Trustees; the annual reports of the officers of the Academy; lists of Additions to the Museum; and an Appendix containing several zoölogical articles. Prof. A. Hyatt gives an account of a specimen of *Rossia palpebrosa* Owen (?) taken from the stomach of a hake at Manchester, Mass.,—a species not before recorded from our coast. Prof. E. D. Cope contributes a Catalogue of Batrachia and Reptilia obtained by J. A. McNiel in Nicaragua, and another of those obtained by C. J. Maynard in Florida; in the former article he describes a new lizard and a new genus and species of serpents (*Enulius murinus*); in the latter a new lizard and a new salamander (*Manculus remifer*). Prof. A. S. Packard gives a list of the Insects collected at Pebas, Ecuador, by Prof. J. Orton, and describes a new species of *Attacus* (*A. Amazonia*). Mr. S. I. Smith contributes a list of the Crustacea collected by J. A. McNiel in Central America, and describes a number of new species belonging to the genera, *Leptopodia*, *Ozius*, *Arenæus*, *Gebia*, *Atya* (2 sp.), *Evatya* (new genus), *Leander*, and *Palæmon*. Several species in the collection appear to be identical with Atlantic species. The omission of the precise dates of publication of these descriptive papers is inexcusable. The report is merely dated "1871."

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* On the Affinities of the Tabulate Corals, in Proc. Amer. Assoc. for Adv. of Science, 1867, p. 148; also Proc. Essex. Institute, vi, p. 90, 1869.

† Since the printing of these remarks (April, 1870), a very interesting new genus of recent tabulated corals has been described by Mr. W. S. Kent, under the name of *Favositipora Deshayesii* (Ann. and Mag. Nat. Hist., vol. vi. p. 384, pl. 17, 18, Nov., 1870). This remarkable form combines a complete tabulate structure of the interior, like *Favosites*, with the ordinary structure of *Alveopora* in other respects, thus fully confirming the views quoted above.

21. *On the Genesis of Species;* by St. George Mivart, F.R.S. 296 pp., 12mo, with numerous illustrations. London, 1871. (Macmillan & Co.)—This work presents the fairest and most successful argument against the sufficiency of the theory of "Natural Selection" which has thus far been published. At the same time, the author, in his two closing chapters, sustains the view of an evolution of species by secondary laws; but laws "for the most part unknown," and among which that of "Natural Selection" is only of subordinate importance. The illustrations are excellent.

## III. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Anthracite Coal Trade of Pennsylvania.*—Mr. Peter W. Sheafer, a well known engineer at Pottsville, Pa., has prepared a diagram exhibiting the progressive development of the Anthracite Coal Trade of Pennsylvania. It embraces the period of fifty years from 1820 to 1870, and an accompanying table gives in detail for each year, the yield of anthracite of the four great subdivisions of the anthracite region, the Lehigh, the Schuylkill, the Wyoming, and the Lykens Valley, Shamokin, etc. We take the export in tons, for the years below specified, from the table:

| | Lehigh. | Schuylkill. | Wyoming. | Lykens V., etc. | Total. |
|---|---|---|---|---|---|
| 1820 | 365 | | | | 365 |
| 1830 | 41,750 | 89,934 | 43,000 | | 174,734 |
| 1840 | 275,313 | 475,091 | 148,470 | 15,505 | 864,384 |
| 1850 | 690,456 | 1,782,936 | 827,823 | 57,684 | 3,358,899 |
| 1860 | 1,821,674 | 3,270,516 | 2,941,817 | 479,116 | 8,513,123 |
| 1870 | 3,172,916 | 3,853,016 | 7,825,128 | 998,839 | 15,849,899 |

The Schuylkill trade began in 1822, with the exportation of 1,480 tons; the Wyoming, now twice the largest, in 1829, with 7,000 tons; the Lykens Valley, etc., in 1839, with 11,930 tons.

2. *Carbonic acid in outside and indoor air.*—According to examinations made at the Massachusetts Institute of Technology, by A. H. Pearson, under the direction of Prof. Storer, the amount of carbonic acid in the air at the Cupola of the State House, Boston (May 18, 1870), was ·03139 per cent of volume; in Newbury st., Boston, near the Institute of Technology, out of 11 trials on different days, ·03798 to ·04999, and on one day (April 1), ·03194; in Clarendon Place, near Berkely st., ·03371. According to the same experimenter, the volume of carbonic acid in the air of a recitation room of the Institute, after recitation, [we omit the date], was found to be ·08929 to ·09762 p. c.; in a small "weighing room" of same, ·13041 to ·13205; in the Myrtle st. Grammar School, ·13431 to ·13659; in the Tremont st. id., ·14335; the Richmond st. id., ·17781; in the Blossom st. id., ·19037; in the Appleton st. Primary School, ·11092; in the Cooper st. id., ·19927; in Music Hall, Tremont st., ·14045; in the Public Library waiting room, on three different days, each, ·13666, ·13747, ·19352.—*Second Ann. Rep. Mass. State Board of Health,* 1871.

3. *Report of the Board of Health of the City of Chicago for* 1867, 1868, *and* 1869, *and a Sanitary history of Chicago from* 1833 to 1870. 332 pp. 8vo. Chicago. 1871.—The officers of the Board, are Samuel Hoard, President; John H. Rauch, M.D., Sanitary Superintendent and Registrar of Vital Statistics; Ambrose Burnam, Health Officer; J. W. Russell, Secretary. The report is illustrated with diagrams and maps, and is an exceedingly important contribution to the subject. The diagrams show that the period of highest mortality at Chicago during the years 1867, 1868 and 1869, was between the 20th of July and 1st of September; and that the period of increase began late in June or very early 1st of July.

4. *Effect of the Eclipse on the Magnetic Needle;* by D. Muller, (Gaz. offic. del Regno d'Italia).—On the 22d of December the magnetic needle followed its usual course till the commencement of the eclipse. It then retraced its steps until it reached its minimum declination at $1^h$ $58^m$, which was the instant of totality. From that moment the ascending motion toward the west began anew, until the needle had regained the exact position it had occupied when the eclipse began.—*Athen.*, Feb. 18.

5. *Establishment of Paul Mohr in Ohio for the sale of fossils and minerals.*—This establishment has been opened at Bantam, Clermont Co., Ohio. Mr. Mohr, of Vienna, is in communication with various European houses, and states that he can furnish specimens or collections at low rates.

6. *Corrosion of Lead pipes.*—A paper on this subject, by Wm. Ripley Nichols, is contained in the 2nd Ann. Rep. of the Mass. State Board of Health, 1871.

7. *Chemical Society.*—Prof. Frankland has succeeded Prof. Williamson as President of the Chemical Society.

## OBITUARY.

Lartet, the discoverer of human relics and remains in caves and Quaternary formations in France, the principal author of the *Reliquiæ Aquitanicæ*, and an active member of the French Institute, died in the department of Gers, during the investment of Paris. He was Professor of Paleontology at the Museum of Natural History, filling the place left vacant by the death of d'Archiac.

Becquerel, the physicist, died in Normandy during the siege of Paris, at the age of eighty.

Guillaume Lejean, Secretary of the Geographical Society of France and author of various Geographical papers, has recently died.

Haidinger, of Vienna, the veteran mineralogist, crystallographer and physicist, and the most active promoter of scientific progress in Austria, died in the latter part of the month of March.

Catalogue of Minerals with their Formulæ and Crystalline Systems; prepared for the use of the students of the School of Mines, of Columbia College; by Thomas Eggleston, Prof. Min. and Met. 2nd ed., 42 pp. 8vo. New York, 1871.

n J Sci., Vol I., Art. LVI. 1871.

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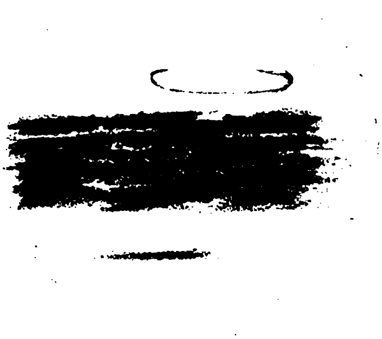

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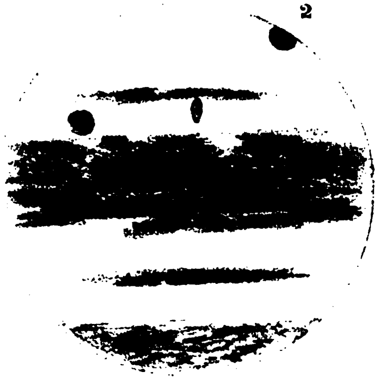

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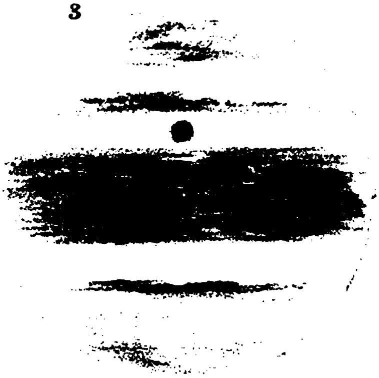

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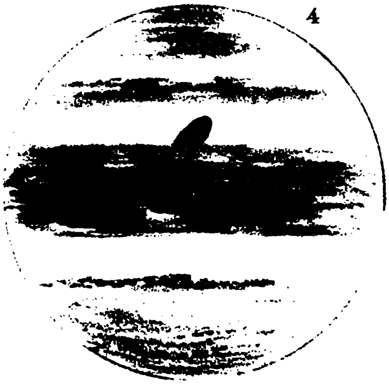

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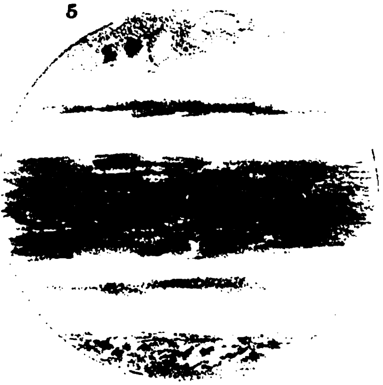

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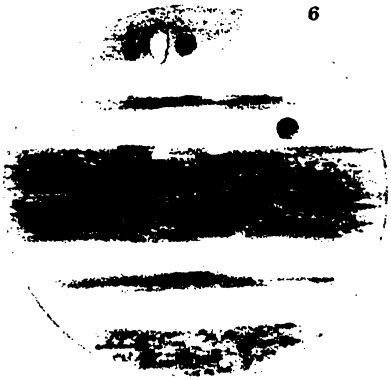

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

## ART. LVI.—*On Jupiter and its Satellites*; by MARIA MITCHELL, Professor of Astronomy in Vassar College. (With a plate.)

THE observations referred to in the following notes were made at a time when the mechanism of the instrument in use was receiving improvements, and the records are therefore those of eye estimates and not of accurate measurements. They do not, however, rest wholly on my own impressions. Separate drawings and estimates were made in several cases by three of my students, Misses Abbot, Glover, and Mead, and my own were checked by theirs.

The characteristics of the phenomena seen on Jupiter's disc in the Fall of 1870 and the Winter of 1870–71 differed from those of the preceding year. The rosy tinge of the equatorial belt was less marked; the dark spots on the same belt were less decided, and the white spots more numerous. In the notes of Jan. 9, 1870, I use the expression "very rosy" in describing the upper edge of the broad belt; words which I could not use in regard to the color, at any time of observation since that date.

The instrument used was the large Equatorial telescope, the object-glass of which is 12¼ inches in diameter.

The oval marking given in fig. 1 was seen Jan. 19, 1870. It is without doubt the same seen by Prof. Mayer at an earlier date.

It is at least a singular coincidence, that a group of small spots on the sun, arranging themselves in the same figure, is recorded on Jan. 22. I record on June 18, 1870, a rosy tinge on the extreme northern edge of Saturn's ring; the night being remarkably good.

Nov. 1, 1870.—Two shadows and one satellite were seen at once on Jupiter's disc. The satellite, which was the first, was faint, brown, and ill defined, when first seen; near the center of the planet, its shape was oval. A large spot could be seen on the fourth satellite.

Nov. 10, 1870.—The narrow southern dark belt has a violet tinge.

Nov. 16, 1870.—A short and broad violet marking was seen near the northern border.

Nov. 28, 1870.—The broad equatorial belt could be seen out to the following edge. There were three large white spots upon it. The third satellite was warmer in tint than the other three.

Dec. 3.—The broad belt was seen again, quite out to the following limb. The first satellite was seen on the planet near the preceding limb, of dazzling whiteness, resembling the polar regions of Mars. White spots were noticed on the broad belt. The fourth satellite seemed to have a halo around it.

Dec. 10, 1870.—I began early to watch for the entrance of the first satellite and its shadow. The planet was low and the air full of tremor. I lost the satellite at once, when it entered upon the planet, and did not see it until 8 P. M., when I found it near the center of the disc. It seemed to be round and was dusky in color. Only twelve minutes later, this round figure had enlarged and become an irregular oval figure, stretching into the broad equatorial belt; it was then very distinct. As the shadow and satellite were thrown upon the planet nearly at the same time, it is probable that they were seen together, but there was no distinction of color. It seemed as large as the third satellite plus about its third. The whole shrunk suddenly, and then disappeared a few minutes after 9 P. M., and at $9^h$ $32^m$ P. M. the satellite reappeared, still on the planet, round and very white. At $10^h$ $5^m$ the broad dark equatorial belt was seen out to the following edge. I have given the changes of the first satellite in figs. 3 and 4. No inequality of brightness could be detected in the bright belt along which the course of the satellite lay.

Dec. 16, 1870.—The noticeable peculiarities are, the continuance of the dark equatorial belt quite out to the limb of the planet, both preceding and following, but more strongly in the latter case, and the unequal brightness of the southern bright belt, presenting in a coarse way something of the appearance of the sun's disc. The third satellite was brighter at the center than at the edges.

Jan. 7, 1871.—A very marked phenomenon is represented in figs. 5 and 6. A white oval spot was seen preceded by two brownish spots at $6^h$ $57^m$. It was afterwards seen only by glimpses, until 7h 36m when it reappeared, but with a change of relative position; it was then between the brown spots. The shadow of the second satellite, very black at first, dimmed as it came to the center, and became elongated.

Jan. 13, 1871.—Two white spots seen near the northern edge seemed to change in relative position in the course of half an hour.

Jan. 16, 1871.—The passages of the first satellite and of the shadow were carefully watched. The satellite was seen through nearly the whole transit; it was lost for about 20 minutes when near the center—at this time the shadow became elongated. When the shadow entered upon Jupiter, it seemed to have a penumbra around it, and to be preceded by a small white spot. A large white spot was seen above the most northern dark belt.

Jan. 19, 1871.—Three large white spots were seen on the dark equatorial belt. The third satellite was on the planet and was smaller than any one of these spots.

In watching the changes of Jupiter's bright cloudy belts or of its dark bands, one is continually reminded of the changes in the sun's photosphere. Although the variations are less marked on Jupiter than on the sun, yet it is true of both, that drawings made at intervals of half an hour would show different relations of dark and light spots.

The changes in the satellites seem to me peculiar. I have watched the first satellite a good deal, and while I have never seen it enter upon, or leave the disc as other than a white circular object, either I have lost it at the center, or it has changed in shape and color,—becoming elongated toward the polar regions, and assuming a reddish-brown hue. The impression made upon the observer is that of the interposition of some medium through which it is seen dim and distorted.

## ART. LVII.—*On the Physical Constitution of the Sun;* by Professor W. A. NORTON.

AMONG the recent theories of the Physical Constitution of the Sun, based on the later discoveries, astronomical and spectroscopic, that propounded a few years since by M. Faye* has been most favorably received. It is an essential feature of this theory that the sun's mass consists wholly, or in a great degree of gases or vapors; and that a process of interchange of solar matter between the interior and the photosphere is in incessant operation, in ascending and descending currents, by which the solar radiation is maintained. In a paper by J. Homer Lane, on the Theoretical Temperature of the Sun, &c., published in this Journal, July, 1869, it is elaborately argued, and appears to be successfully maintained, that the great rapidity of circulation required by this theory cannot subsist consistently with the received laws of gaseous circulation. Quite recently another theory of the sun's physical constitution has been propounded by Professor F. Zöllner of Leipzig; based mainly on the well established fact that the solar protuberances, conspicuously visible in total eclipses, and observable at all times with the aid of a spectroscope, are most of them due to violent eruptions of masses of incandescent hydrogen.* He remarks that "it is impossible, without passing beyond the well known analogies necessary for the explanation of cosmical phenomena, to assign any other cause to these eruptions than the difference of pressure of the gases emanating from the interior and from the surface of the sun. To make such a difference of pressure possible it is necessary to admit the existence of a separating stratum between the inner and outer strata of hydrogen—the latter of which, as is well known, forms an important portion of the solar atmosphere. In reference to the physical constitution of this stratum, we must furthermore assume that it cannot be gaseous, and must therefore be either solid or liquid." He remarks further, that "with regard to the inner masses of hydrogen bounded by that stratum, two suppositions are possible, viz: 1. The whole interior of the sun is filled with incandescent hydrogen gas, which would make the sun an immense bubble of hydrogen surrounded by a liquid glowing envelope. 2. The masses of hydrogen, bursting out into protuberances, are local collections in bubble-like caverns, which form in the superficial layers of a liquid glowing mass, and burst through when the pressure of the confined gas increases." Prof. Zöllner adopts the latter supposition as the more probable of the two.

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* Comptes Rendus, vol. lx, pp. 89 and 138.

This theory may furnish an adequate supposable cause for the observed eruption of incandescent masses of hydrogen, but its fundamental hypotheses have no secure ground to rest upon. The notion, that the sun's photosphere is in the liquid state, is irreconcilable with the astonishing rapidity with which changes often occur on the sun's surface, and also with the fact that the vast elevated masses, seen as the faculæ, occasionally retain the same position for several days; and though suggested long since, has not, to my knowledge, been adopted by any astronomical observer. No hypothesis of the possible origin of the sun's spots, upon this idea, has been framed that affords a satisfactory explanation of even their more conspicuous features and phenomena. To this remark the theory advanced by Prof. Zöllner, viz: that "the nucleus of the solar spots is a scoriaceous product of local cooling on a liquid surface, and the penumbræ clouds of condensation, which surround at a certain height the coasts of these islands of slag, offers no exception." It is not new, and has been already overthrown by the investigations of M. Faye.* The other fundamental hypothesis of Professor Zöllner's theory of the physical constitution of the sun, viz: that the masses, which burst out into protuberances, are local collections in bubble-like caverns, which form in the superficial layers of a liquid glowing mass, does not derive any support from analogical facts. It must be regarded as a pure hypothesis, unsustained by any inherent probability, or by any known fact, other than that which it is framed to explain. Besides, an hypothesis which brings the hydrogen in eruptive, or streaming masses, to the sun's surface, does not suffice. Another arbitrary hypothesis is required to dispose of the hydrogen which has thus been accumulating above the sun's photosphere for an indefinite period of time.

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* Journal of the Franklin Institute, Nov., 1870; also Philosophical Magazine, Nov., 1870.

Such being the state of the case with regard to the recent attempts to discover the secret of the sun's physical constitution, in the light of the late remarkable discoveries, we seem to be in this dilemma; whatever conception is formed of the condition of the sun's photosphere—whether liquid or gaseous—it appears to be contradicted by received principles, or controverted by established facts. We are thus naturally led to suspect that either some physical cause has been hitherto left out of account, which plays an important part in solar phenomena, or else the conception adopted of the mechanical condition of the solar vapors is radically at fault. It appears to me that good and sufficient reasons may be urged that will justify both these grounds of suspicion; and that a new point of view may be gained from which we may obtain a deeper insight into the physical processes in operation on the sun.

It is a little remarkable that it should have been hitherto assumed that the facts and laws of Terrestrial Physics can alone furnish a true philosophical ground for a theory of Solar Physics; and that no serious attempt should have been made to obtain additional light from known processes in operation on a cosmical scale in the regions of space. There is a class of bodies, some of which in their periodical excursions through the fields of space approach quite near the sun, and which are in general conspicuously subject to influences of a powerful nature exerted by the sun, besides the force of gravitation. It certainly seems natural to expect that these cosmical bodies might give us some insight into the nature of the forces in operation at the sun's surface. It is assuredly too late to urge that the transformations which they undergo under the sun's influence are wholly involved in mystery; for it has certainly been satisfactorily established that a portion of the cometary matter becomes subject to a *solar repulsion*, and is urged away by this force with a high velocity, and to great distances from the sun, and that this repulsion augments in intensity as the comet approaches the sun.* Now if such an energetic force of repulsion emanates from the sun, and operates on cometic matter at all distances, both small and great, according to the law of inverse squares, there is assuredly a high probability that it may play an important part on that vast arena, where solar forces are obviously engaged in fierce contention. It may be conjectured that the solar vapors are entirely different substances from, and wholly unlike, in their physical state, the cometary vapors that appear to be so exceedingly subtil. But it is certainly more philosophical to suppose that the same substances, or substances possessed of the same general properties, are present in all cosmical bodies, and the earth. Besides we are not without direct evidence on this point. Huggins, by examining the spectrum furnished by the light emitted from the Comet II, 1868, detected the presence of the vapor of carbon in the brighter portions of the comet. "He has been able to discriminate between the light of the nucleus of a comet and that of its tail. The nucleus is self-luminous, and its substance is in the form of ignited gas. The coma shines by reflected light as clouds do."

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* Comptes Rendus, vol. lxi, p. 1089.

If, as is now conceded by astronomers, the tail of a comet is made up of matter detached from the general mass of the comet, by reason of a repulsive action exerted by the sun, it must also be admitted that the matter expelled is not all urged away by the same intensity of force, and with the same velocity; for we find that it is much more widely dispersed in the plane of the cometary orbit than is consistent with this supposition. For example, I have shown, in my theoretical discussion of Donati's Comet,† that if we conceive particles of matter to have been expelled from this comet, with a certain small lateral velocity, and urged away during a certain interval of time by a solar repulsion bearing to the force of gravitation the ratio of

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* This is generally, if not universally, admitted by astronomers. The author has undertaken in former numbers of this Journal, to establish by rigorous calculation that the luminous train of Donati's comet was developed by a force of solar repulsion coöperating with the attraction of gravitation—both varying according to the law of the inverse squares. (See this Journal, vol. xxxii.)

† This Journal, II, vol. xxxii, pp. 54–66.

1·213 to 1, they would, at the end of the interval, have been found distributed over a narrow band coincident, at its forward line, with the curved preceding side of the tail of the comet; and that the other portions of the tail must have been composed of matter subject to various degrees of solar repulsion less than this. In fact the definite conclusion was in this way reached that the preceding half of the tail consisted of matter repelled from the sun with a force varying between the limits 1·213 and 0, and that the following half was for the most part composed of matter detached from the comet simply by reason of a weakened gravitation toward the sun,—the intensity of the force of gravitation along the following side of the tail being 0·455. There would seem then to be no alternative but to admit that the tail of Donati's comet was composed of different substances, (or else of one substance in different physical states) subject to a repulsive action from the sun of various degrees of intensity; and either prevailing over the sun's attraction of gravitation, or partially counteracting it, and so giving rise to an effective repulsion for certain of these substances, and to a diminished gravitation for others. The simplest theoretical explanation that can be given of this state of things is to suppose that the *solar repulsion consists of a series of impulses propagated in waves through the ether of space, and taking effect upon atoms of different sizes with varying intensity.* It is obvious that if this be true, the smaller the atom the more effective should be the repulsion as compared with the gravitating force soliciting the atom; since the ratio of the two forces should be proportional to the surface divided by the volume of the atom,—assuming that the mass is proportional to the volume, or that all atoms have the same density. We are thus incidentally led to infer that the larger comets consist of a variety of substances, like the earth.

The question now arises what can be the origin of the force of solar repulsion. There is another side of the diversified picture presented by cometary transformations under the sun's influence, which gives some intimations on this point. Not only is a certain portion of the cometary matter repelled by the sun, but it is also repelled by the nucleus of the comet. We see in large comets, a series of envelopes rise at intervals from the nucleus, on the side turned toward the sun, and recede at a nearly uniform rate until they become dissipated by the sun's repulsion. Luminous jets also stream out at times from the same side of the nucleus. These phenomena, it can hardly be doubted, are in some way the effect of the sun's heat. The simplest and most probable conclusion is that the ejecting force which is brought into play by the sun's heat is the direct repulsive energy of the heat received by the comet. We are thus led to infer that *the repulsive action exerted by the sun upon matter in the state of the cometary vapors, probably consists, either wholly or partially, in repulsive impulses propagated in the heat waves proceeding from the sun.*

Let us now see whether any confirmation of these inferences, and any additional light in the direction of our present inquiry, can be obtained on the substantial ground of Terrestrial Physics. The definite question presented for consideration, is whether the results of observation or experiment afford any indication of a direct repulsive action exerted by radiant heat on the atoms of bodies. It is universally admitted that radiant heat, when imbibed by a body, acts as a repulsive or separating agency among its molecules. It is also conceived that the conduction of heat is by radiation from atom to atom. The most natural inference from these facts is that the waves of radiant heat, which pass from atom to atom, directly urge the atoms away from each other by repulsive impulses. Instead, however, of adopting this simple idea, physicists have generally been inclined to refer the expansion of bodies from heat to some mode of motion of the atoms, originated by the heat received; though no detailed satisfactory explanation has yet been given of the manner in which such motions would directly originate an expansion. Strangely enough this notion is even entertained by physicists who regard heat as the only cause of the repulsion subsisting among the molecules of bodies. It should here be noted, that if the expansion of all bodies of matter from heat is to be ascribed to a direct impulsive, or repulsive action of heat waves proceeding from one atom and falling upon the surrounding atoms, then this force takes effect at the greatest distances by which the atoms are separated in the rarest gas under the feeblest pressure; and we would thus be led to expect that heated bodies in contact with each other might manifest signs of repulsion.

In point of fact, many evidences of a heat repulsion subsisting between particles of different bodies, in contact or in close proximity, have been adduced by different experimentalists, and writers on physics, some of which may be briefly mentioned.

1. "When pure silica, in an extreme state of division is highly heated, the slightest motion then causes the particles of the powder to slide over each other, and the surface of the powder is thrown into undulations almost like those of a liquid."

2. A rise of temperature is attended with a decrease of capillary attraction. Also the frictional resistance to the flow of water in pipes is diminished by heat.

3. "The spheroidal state of liquids is a complicated result of four distinct causes. The most influential is the repulsive force which heat exerts between objects which are closely approximated to each other."*

4. The vibrations of heated metals, as shown in "Trevilyan's Instrument," or "rocker," resting on a block of metal, are probably due to the direct repulsive force of heat, as maintained by Professor Forbes, of Edinburgh, in opposition to Faraday, who conceived that they were attributable to the sudden expansion by heat of the body on which the rocker rests. Faraday's explanation of these curious phenomena is adopted by Tyndall, who endeavors to overthrow Prof. Forbes's theory. His experiments serve to disclose the fallacy of certain features of the theory, but do not dislodge the fundamental idea that the phenomena are due to a force of heat-repulsion. This might be made apparent if we had space for a statement of the general principles on which the explanation rests, and for a detailed discussion of the results of the experiments.

Let us now consider if any sufficient evidence exists of a general force of molecular repulsion in operation at all temperatures,—beyond the sphere of sensible adhesion, or cohesion. We need, in fact, to look no farther for this than to the simple fact that in the ordinary contact of bodies the interval of distance between them, minute as it is, much exceeds the range of the attraction of cohesion, or adhesion; for in such contact the weight of the upper body is counteracted by a repulsion between the molecules about the point of contact. Dr. Robison has shown in his System of Mechanical Philosophy, that if two glasses, one slightly convex, the other flat, are placed on each other and pressed by a force of 1000 pounds to the square inch, they are still at the distance from each other of the thickness of the top of a soap bubble just before it bursts, or at least $\frac{1}{4450}$th of an inch. In effecting this contact there was no evidence of any attraction existing at distances greater than that at which the contact occurred. A similar remark may be made with regard to all cases of the apparent contact of homogeneous substances under a moderate pressure. It is only by increasing the pressure more or less, that the contiguous particles can be brought within the range of their reciprocal attraction of cohesion. When the particles are readily displaced among themselves under the direct action of a pressure, or blow, as in the case of soft or malleable substances, a permanent union may be effected without difficulty between the surfaces; that is, the outer repulsion of some of the particles may be overcome, their attraction of cohesion brought into play at the reduced distance, and an equilibrium established at the neutral point between this attraction and the inner repulsion. This occurs in the welding of iron.

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* Miller's Physics, p. 285.

Other evidences of an effective repulsion in operation between the molecules of bodies in contact, or in close proximity, are cited in treatises on Physics; although it is not always distinctly recognized that the sphere of its action lies entirely without that of the effective molecular attraction. Now what is the range of this *effective* repulsion between bodies. It obviously extends only to a small distance. Cavendish's well-known experiment has established that, when bodies are separated by considerable distances they tend toward each other by the attraction of gravitation. But are we therefore to conclude that the repulsive action, so energetic at the near approach of the molecules, has vanished altogether when they are a considerable distance apart. Is it not more probable that this force is confined to the surface molecules, and disappears at moderate distances, in comparison with the attraction of gravitation which is the result of the action of the entire masses on each other, because it decreases according to the inverse squares of the distance between the surfaces instead of the distance between the centers. I have elsewhere shown* that the force of gravitation cannot be the attraction of cohesion operating at considerable or great distances. It is a force *sui generis*, entirely distinct from the forces of molecular attraction and repulsion in operation at minute distances, and determining the constitution of bodies and their mechanical properties; and operates in conjunction with, but independently of, these molecular forces.†

In view of the concurrent testimony that we have now seen is afforded by the two departments of Cometary, and Terrestrial Physics, it will be admitted that, in attempting to gain a new insight into the physical constitution of the sun, and the processes of change in operation on its surface, we are at least entitled to assume the following as probable hypotheses.

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* Philosophical Magazine, vol. xxxviii. p. 38.

† It ought here to be stated, that in my paper on Molecular Physics published in this Journal, vols. xxxviii, xxxix and xl. I have deduced from the fundamental conception of a primitive molecule (or chemical atom) adopted, a force of molecular repulsion operating beyond the sphere of the molecular, or cohesive attraction; and reached the conclusion that this force has its immediate origin in the physical change to which the development of heat is in every instance due, viz: an inward or contractile vibratory movement of the electric envelopes by which all atoms are conceived to be surrounded, as well as by ethereal atmospheres. It is accordingly termed the molecular heat-repulsion. The repulsive energy of heat in operation on any molecule, is the sum of all the ethereal impulses developed by such movements of the envelopes of other molecules, (whether originating in the attraction exerted by the central atoms on their envelopes, or in an external collision or pressure), and propagated to the molecule. From the principle of interception of wave-force it results that the external repulsive action exerted by a solid body is confined to the surface molecules; while a force of heat-repulsion is propagated to an indefinite distance from all the molecules of a gas.

1. That the sun exercises a repulsive action upon the molecules of every gas or vapor that subsists at its surface, or is at any time in any part of the region of space exterior to the surface; that this force is the sum of all the heat impulses propagated in ethereal waves from all the gaseous molecules posited above the solid or liquid body of the sun, and from the surface molecules of this central mass, except in so far as these impulses may be intercepted in their passage; and that it is opposed to the force of gravitation, which is due to a virtual attraction of the sun's entire mass,—so that the effective force soliciting any gaseous molecule is the difference between these two forces, attractive and repulsive, by which it is urged.

2. That the force of solar repulsion, since it consists of impulses propagated in ethereal waves, is comparatively more effective in proportion as the atomic weight of the solar vapor is less; it being assumed that the quantity of matter in any atom is proportional to its volume.

3. That in a hypothetical condition of equilibrium of the sun's atmosphere the elastic force of each of its vaporous constituents, at any depth, will consist in the intensity of the effective heat impulses tending to urge its molecules outward; which will be counteracted by the weight of the superincumbent portion of the atmosphere. Now, let us assume, for the moment, that at some anterior epoch in the sun's history, all the present vaporous constituents of the sun's atmosphere were diffused throughout a space exterior to the central body of the sun and limited by the spherical surface (A), at which the molecules of the vapor of greatest atomic weight are in equilibrium, under the action of their own weight and of the heat-repulsion urging them upward. This hypothetical state of things could not continue, since the atoms of each of the other solar vapors would be urged upward by an effective force. If we conceive a small quantity of each of them to escape from all points of this surface, the rising vapors will ascend to greater heights in proportion as their atomic weights are less, and finally, when the equilibrium is attained, form a series of spherical envelopes, wholly detached from each other, and arranged in the order of atomic weights;—beginning with the heavier metallic vapors, and terminating with the lighter (potassium, sodium, &c.), and the permanent gases, with hydrogen outermost. If other small portions of each of the vapors were to rise from the surface, A, they would serve to augment the thickness of the envelopes already formed; and the same would be true for each successive discharge. The final result would be the same if the discharge were continuous during a certain interval of time, as

would naturally happen. After a certain amount of the solar vapors have escaped, contiguous envelopes might interpenetrate each other more or less. What it is especially important to observe, is, that *throughout the whole depth intercepted between each envelope, and the outer limiting surface,* A, *of the vapor of greatest atomic weight, every atom of the substance of which the envelope is composed, that may chance to be present, is urged upward by a force of repulsion.* If, as we must suppose, the rise of the solar vapors from the surface, A, continues for an indefinite time, the interpenetration of contiguous envelopes would increase, and eventually a condition of equilibrium would be attained; if the sun's temperature remained the same. But if this temperature were to increase, as it must down to a certain epoch in the process of consolidation, the process above indicated would be continually renewed. It is still more important to observe, that if there were any cause in operation withdrawing continually at short intervals a portion of one or more of these rising vapors, a statical equilibrium would not be reached; and it would be permanently true that *for every such vapor there would be a region of repulsion,* as above stated, *extending from its envelope down to the outer limit,* A, *of the vapor of greatest atomic weight.* Throughout this region the vapor would be perpetually rising, taking the place of that which is withdrawn, and so maintaining a *dynamical equilibrium.* The depth of this region would be the greatest for hydrogen, the outermost gas (unless there is some solar vapor of less atomic weight than hydrogen). Now it is easy to see that a certain physical cause tending to produce such results, must come into operation at some stage of the sun's process of consolidation. As conceived by Faye, the cooling going on at the outer surface must eventually bring the temperature there down to the point at which the vapors having the highest affinity for oxygen will undergo combustion. The products of such combustion, being compound molecules, will have a greater weight in comparison with the repulsion to which they are exposed, than the simple molecules before the combination took place, and hence they will descend, more or less rapidly, into the depths of the photosphere. To all appearance the sun is now passing through this period of its physical history, as supposed by Faye; and in the "granulations" which give to the solar disc a mottled appearance (Herschel's "subsiding chemical precipitates,") we probably discern the products of the combustion occurring in the upper photosphere and determining its outer limit, in the act of descending. The continual upward flow from the depths of the photosphere, of the hydrogen, oxygen, and the lighter metallic vapors, will bring about the necessary intermixture of oxygen with the other vapors. This must occur below the natural outer limit of the hydrogen envelope; and we know that as a matter of fact, the chromosphere, composed chiefly of hydrogen, extends above the photosphere.

If the products of the surface combustion were all to descend indefinitely into the vaporous photosphere, without undergoing decomposition, no farther visible effects would ensue. We could only follow with the mind's eye the gradual growth of the central nucleus of the sun, and recognize that we probably have before us a picture of the process by which the materials of the earth's crust were fashioned and accumulated in the earlier ages of its history. But the probability is that the descending masses would eventually arrive at a depth where the higher temperature would effect a dissociation of the combined elements (as Faye supposes). This must inevitably happen unless the tendency of the heat, that augments with the depth, is counteracted by the opposing tendency of the increasing gaseous pressure. By reason of these opposing tendencies it may well happen that there may be a certain region of dissociation of limited depth, above and below which decomposition would not occur. But it is to be observed that it does not follow that all of the products of surface combustion as they pass through such a region would be decomposed; since the reduction of temperature attending every instance of decomposition tends to prevent decomposition of other surrounding masses in the act of descending.

This sudden dissociation of large masses of combined elements, though occurring at certain depths within the photosphere, it will be seen may eventually play a conspicuous part at the surface. Unless the region of dissociation should lie below that of repulsion for the elements separated, these elements after separation will be urged upward by the effective force of repulsion, ascend rapidly, and emerge with a high velocity above their respective envelopes. The ascensional velocities attained will be greater if large masses are suddenly decomposed. The masses of hydrogen set free should attain to the greatest velocity, and rise to the greatest height. They should rise, in eruptive masses, above the hydrogen envelope, or in other words, the chromosphere. According to Lockyer, in the solar protuberances, the ascending hydrogen has in some cases, a velocity as high as 120 miles per second, and rises to a height of more than 40,000 miles.

A vertical jet of hydrogen, having a projectile velocity of 120 miles per second, should attain an altitude of 43,000 miles, if the solar gravity were constant for that altitude. Some prominences have extended to a height of 100,000 miles above the sun's photosphere. Prof. Respighi, has even noticed instances of an elevation of 160,000 miles. Such enormous heights imply either a greater initial velocity than 120 miles per second, or that the full energy of the solar attraction does not take effect on the eruptive masses of hydrogen, in the region above the photosphere. From our theoretical point of view, we perceive that the latter supposition should be true; since the solar repulsion should be in operation above the hydrogen envelope, or the chromosphere, diminishing the gravitating tendency.

The metallic vapors set free in the region of dissociation, should rise to heights varying with their atomic weights. Some of them, especially the lighter ones (sodium, magnesium, calcium, &c.), may acquire velocities sufficient to bring them above the chromosphere. In fact the spectroscope has detected besides hydrogen, magnesium, sodium, iron, and chromium, in the solar protuberances. Lockyer states that he has invariably found that in solar storms, the chromospheric layers are thrown up in the order of vapor density. He regards the chromosphere as built up of the following layers, which are in the order of vapor density in the case of known elements: a new element giving the green coronal line in the spectroscope, hydrogen, another new element, magnesium, sodium, barium, iron. He remarks that "all the heavier vapors are at or below the level of the photosphere itself."*

The green coronal line was traced in the late eclipse by Profs. Young and Winlock as far as 16′ or 425,000 miles from the sun's limb. From our present theoretical stand-point, we naturally infer, as Lockyer has already done from his observations, that the element present in the solar corona which gives this line is much lighter than hydrogen. We see also that an element several times lighter than hydrogen might be subject to a solar repulsion that would predominate over the attraction of gravitation at all distances, and urge the subtil vapor indefinitely away from the sun. Since the same line is seen in the light of terrestrial auroras, we must conclude that the same substance is present in our upper atmosphere;—either in a permanent upper layer, or derived from the sun (as I have elsewhere maintained). We must infer also that it is magnetic, which apparently cannot be the case unless it takes on the condition of compound molecules. Such compound molecules might become dispersed in the upper atmosphere of the earth, or in the photosphere of the sun, by electric discharges or sudden evolutions of heat; and then the separate atoms repelled off, forming the streamers of the corona and aurora, illuminated either by electric light, or in the case of the corona in part also by reflected solar light.*

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* It is admitted by Angström, and Zöllner, that the absence of spectroscopic indications of oxygen and nitrogen in the sun, is no sufficient evidence that these gases are really wanting in the sun's atmosphere.

The probable origin of the sun's spots, and other questions of solar physics that claim attention, must be left for future consideration. I will only remark here, that it has long been apparent that the diverse phenomena which occur at the sun's surface are traceable, more or less directly, to the action of some form of eruptive force. *The present investigation seems to have led to the discovery of the true nature and origin of this force; and at the same time to have revealed the process by which the sun's radiation is maintained.* The primary source of the solar heat being, doubtless, as now generally believed, the process of condensation maintained by the force of gravitation.

It is worthy of remark, in conclusion, that as comets directed our attention, at the outset, toward the sun, so the sun, in its turn, leads us back again to our starting point; since we see that if we transfer to cometary bodies the physical structure we have recognized in the sun's upper photosphere, viz: the existence of a succession of light vaporous envelopes, subject to the energetic action of the force of heat repulsion, the mystery in which some of the curious transformations they undergo, have hitherto been involved, seems to be in a great degree dispelled. No one doubts that comets are chiefly composed of very light vapors; though some of the larger ones may have a solid nucleus. If, as intimated, certain observed cometary phenomena indicate that these vapors, like the solar vapors, are arranged, for a certain depth at least, in envelopes, which are liable to be greatly expanded, or even wholly expelled by the increasing amount of heat received from the sun, we have in the probable physical structure of comets, another indication that these bodies were originally detached from the sun's photosphere, in addition to that furnished by certain features of the cometary motions.†

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* It is also conceivable that the subtil vapor streaming off in the coronal rays, has been set free by dissociation like the hydrogen, from some other element of a compound substance, in the depths of the photosphere. However this may be, it can hardly be doubted that the ascent and descent of the solar vapors, and the combinations and decompositions going on among them, must be attended with disturbances of electric equilibrium, from which decided effects must result.

† Norton's Astronomy, revised edition, p. 276.

## ART. LVIII.—*On the Composition of Permanent Illuminating Gas obtained from the decomposition of Petroleum Naphtha;* by H. H. EDGERTON. With a prefatory note by B. SILLIMAN.

THE conversion of the light napthas resulting from the rectification of Pennsylvania petroleum into a permanent gas, suited for economical use as an illuminant, either by itself or when mixed with poor gas, or atmospheric air as a diluent, is a problem of no little importance; especially in view of the enormous volume of these light products, equal to at least one-eighth part of the total production of crude petroleum. A process for converting this volatile material into a permanent gas has been devised, and is coming into notice under the name of "Rand's process," which is in fact founded upon an invention patented some years since by Dr. L. D. Gale. In this process the vapor of naphtha evolved in a distillating apparatus by a steam coil is carried into an iron retort heated to redness where it is in great part converted into permanent gases of very high illuminating power. Small portions of the denser oils which escape destructive distillation are delivered by a syphon into a suitable receptacle; while the gas, after cooling, is carried to the holder and is fit for immediate use. It is so rich, however, in illuminants as to be unfit for use in common gas burners, and hence is usually reduced by admixture with atmospheric air, of which it requires about an equal volume to bring it to a standard of 25 candles by the photometer.

As this problem possesses considerable scientific interest, aside from its economical importance, I have requested Mr. H. H. Edgerton, Superintendent of the Gas works at Fort Wayne, Indiana, who is a well instructed and skillful gas chemist, to communicate for publication his analytical results upon the constitution of the naphtha gas, which are subjoined.

The "Memphis Gas" quoted in these analyses is the gas made at Memphis, Tennessee, by this method, that city being thus lighted. By "Fort Wayne N. Gas" Mr. Edgerton means the naphtha gas made by himself at Fort Wayne. In a letter Mr. Edgerton says he has calculated the gases which are not absorbed by Nordhausen acid as methyl or marsh gas, and the absorbable gases as $C_4H_4 + C_8H_8$, although he adds, "I am convinced these gases do not co-exist, but go to form an intermediate gas, of less simple relation of volumes."

The economical details of this interesting research are given in a separate form elsewhere. It will be a source of great satisfaction should this method of utilizing light naphtha become an established industry, since in this manner alone can we hope, by consuming the raw material, to avoid those constantly recuring disasters from the use of "dangerous kerosene," made dangerous by the fraudulent addition of these volatile hydrocarbons, by reason of which many hundreds of lives are annually sacrificed. B. S.

*Constituents of Naphtha Gas reduced to* 100 *volumes.*

*"Memphis Gas."*

| | |
|---|---|
| Hydrocarbon illuminating gases, | 25·42 |
| Marsh gas, | 34·16 |
| Methyl, | 3·29 |
| Nitrogen, | 32·24 |
| Oxygen, | 4·89 |
| | 100·00 |

*"Fort Wayne Gas."*

| | | 1st analysis. | | 2d analysis. | |
|---|---|---|---|---|---|
| Elayl (Olefiant gas), | $C_4H_4$, | 37·54 | 55·81 | 38·28 | 55·81 |
| Ditetryl (Butylene), | $C_8H_8$, | 18·27 | | 17·53 | |
| Marsh gas, | $C_2H_4$ | 13·98 | 44·19 | 13·98 | 44·19 |
| Methyl, | $(\overset{2\,\text{vol.}}{C_2H_3}\ \overset{4\,\text{vol.}}{C_4H_6})$ | 30·21 | | 30·21 | |
| | | 100·00 | | 100·00 | |

*Condensation of Hydrocarbons absorbable by concentrated Sulphuric acid. In analysis of Memphis gas.*

| | | | |
|---|---|---|---|
| Gas employed, | 41·47 | of which 7·143 | absorbable by $SO_3$ |
| Less Nitrogen, | 13·37 | 20·957 | non-absorbable. |
| Combustible gas, | 28·10 | | |

According to previous analysis, due non-absorbable gases.

| | Due non-absorb. | Vol. absorb. | Due absorb. | Per vol. |
|---|---|---|---|---|
| Carbonic acid, | 22·80 | 7·143 | 19·40 | 2.716 |
| Oxygen used, | 52·136 | | 21·50 | 3·010 |
| Contraction, | 50·293 | | 7·21 | 1·009 |

*Fort Wayne Naphtha Gas.*

Gas employed, 6·819, of which 55·81 pr. ct. absorb. Vol. 3·806.

| | Due non-absorb. | Per vol. | Due absorb. | Per vol. | Total. |
|---|---|---|---|---|---|
| Carbonic acid, | 5·073 | 1·683 | 10·103 | 2·654 | 15·176 |
| Oxygen used, | 9·081 | 3·013 | 15·604 | 4·100 | 24·685 |
| Contraction, | 7·023 | 2·339 | 9·129 | 2·398 | 16·152 |

*Second trial.*—Gas employed, 7·000, of which

| | Non-absorbable. | | Absorbable. | | Total. |
|---|---|---|---|---|---|
| | 3·093 | per vol. | 3·907 | per vol. | |
| Carbonic acid, | 5·208 | 1·683 | 10·260 | 2·626 | 15·468 |
| Oxygen used, | 9·321 | 3·013 | 16·204 | 4·147 | 25·525 |
| Contraction, | 7·210 | 2·339 | 9·381 | 2·401 | 16·591 |

*Analyses of Petroleum Naphtha Gas, February and March,* 1871.

| | V. | V. KO | V. Pyro gal. | V. SO 3 HO | CO 2 Pr. ct. | O Pr. ct. | Hydro-carb. Pr. ct. | R. V. | R. V. +air. | O added. | N added. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Memphis Gas,*..... | 167·18 | 167·18 | 160·66 | 118·13 | None. | 4·91 | 25·42 | 21·13 | 217·03 | 280·67 | 162·90 |
| " " †..... | 41·47 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 541·40 | 2·08<br>104·78 | 395·15 |
| Ft. Wayne N. Gas,‡ | 193·15 | 193·15 | 192·36 | 107·81 | None. | 0·41 | 55·81 | 13·49 | 210·51 | 41·29 | 155·71 |
| " " " § | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 19·46 | 351·16 | 69·52 | 262·17 |
| " " " ‖ | ---- | Bunse | n's met | hod. | ---- | ---- | ---- | 19·59 | 252·93 | 269.90<br>48·91<br>16·96 | 184·43 |
| " " " ¶ | 7·36 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 144·76 | 28·80 | 108·61 |
| | 7·21 | ---- | ---- | ---- | --- | ---- | ---- | ---- | 184·02 | 37·06 | 139·75 |
| " " " ** | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 6·56 | 119·29<br>119·07 | 23·58 | 88·93 |

TABLE OF ANALYSES—continued.

| | After explo-sion. | R. V. KO | R. V. Pyro-gal. | R. V. +H | R. V. 2d ex-plosion. | R. V.—RN | CO 2 found. | O used. | O con-tracted. | For 1 or 100 volumes. CO 2 | O | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Memphis Gas,*... | 249·28 | 235·05 | ---- | 608·88 | 392·41 | 13·08 | 14·23 | 32·54 | 31·39 | ---- | ---- | ---- |
| " " †... | 483·90 | 441·70 | 408·51 | ---- | ---- | 28·10 | 42·20 | 73·63 | 57·50 | ---- | ---- | ---- |
| Ft. Wayne N. Gas,‡ | 180·34 | 158·56 | 156·26 | ---- | ---- | 12·94 | 21·79 | 39·00 | 30·16 | 1·68 | 3·01 | 2·33 |
| " " " § | 308·41 | 277·31 | 263·76 | ---- | ---- | 17·88 | 31·10 | 55·97 | 42·75 | 1·74 | 3·13 | 2·39 |
| " " " ‖ | 230·76 | 205·76 | ---- | 347·41 | 293·89 | 16·21 | 25·00 | 48·03 | 39·14 | 1·63 | 3·18 | 2·55 |
| " " " ¶ | 128·17 | 112·70 | 108·95 | ---- | ---- | 7·00 | 15·47 | 25·04 | 16·59 | 2·21 | 3·29 | 2·37 |
| | 167·87 | 152·20<br>152·70 | ---- | 188·57 | 151·16 | 6·819 | 15·18 | 24·68 | 16·15 | ---- | ---- | ---- |
| " " " ** | 106·11 | 97·09 | ---- | 133·82 | 112·78 | 5·461 | 9·018 | 16·522 | 13·186 | 1·651 | 3·025 | 2·414 |

V.=Volume. R. V.=Residual Volume. R. V.—RN=Residual vol. employed after deducting N found.

* Memphis gas before going into "air mixer," supposed to be pure Naphtha gas.

† To find condensation of absorbable hydrocarbons.

‡ Yielded from commercial benzine at rate of 80 cubic feet per gallon.

§ Analysis of residual gas from same after standing over water.

‖ Another trial of residual gas after absorption of illuminating gases, the absorption made on a quantity contained in a glass holder; sp. gr. of same by Bunsen's diffusion method ·779.

¶ Combustion of same gas (No. 5, second series) before absorbing hydrocarbons to ascertain condensation—two trials.

** Analysis of residual gas after passing No. 5 through Liebig bulbs containing bromine, through water and caustic potash solution. Weight taken before and after of each:

| | Before. | After. | | |
|---|---|---|---|---|
| Bromine,.... | 52·402 | 67·760 | Weight of hydrocarbons absorbed, | 4·788 grams. |
| Water, .... | 95·580 | 106,220 | Vol. of gas passed,.............. | Lost. |
| Potash,..... | 74·770 | 53·550 | " " residual gas, ............ | 201·06 cub. in. |
| | 222·752 | 227·530 | | |
| | | 222·752 | | |
| | | 4·778 | Sp. gr., .................. .... | ·796 |

These analyses agree in the main, that one volume of absorbable gas forms on explosion 2⅔ vol. of carbonic acid, and the illuminating power, compared with olefiant gas, is one-third greater, or as 1 to 1⅓, according to Mr. Lewis Thompson's rule. The sp. gr. of hydrocarbons, found by an indirect method, was 1·271. The candle-power of the Fort Wayne gas would be, therefore, according to the chemical standard 74·41 candles, or 5 to 6 times that of ordinary coal gas. The actual candle-power by photometric test is much higher.

The analyses were all made (with one exception) with Prof. Frankland's apparatus. Owing to a disproportion of parts, the "laboratory tube" being exceedingly small, holding only one-third contents of measurer, but a very small quantity of gas could be analyzed,—about ½ c. c. when nitrogen was present. To give an idea of the experimental error on so small a quantity, four analyses of *air*, by electrolytic H are added.

| 1st. | | 2d. | |
|---|---|---|---|
| Air emp. (expanded vol.) | 62·5 | Air emp. (unex. vol.) | 6·877 |
| After H, | 125·9 | After H, | 14·519 |
| After explosion, | 87·3 | After explosion, | 10·182 |
| ⅓C=12·87 per ct. | O=20·59 | ⅓C=1·4457 per ct. | O=21·023 |

| | 3d. | 4th. | |
|---|---|---|---|
| Air employed, | 14·827 | 7·547 | |
| After H, | 30·088 | 14·790 | |
| After explosion, | 21·028 | 10·496 | |
| ⅓C=3·020 per ct. | O=20·368 | ⅓C=1·431 | per ct. O=18·969 |

Fort Wayne, Indiana, March 20, 1871.

## ART. LIX.—*A Historical Note on the Method of Least Squares*; by CLEVELAND ABBE, A.M.

It is well known that the "Method of Least Squares," although first published in printed form by LeGendre in 1806, in his "Nouvelles Methodes," was first invented by Gauss as early as 1795, and had for years been taught by him in his lectures to his students at Göttingen. It was, however, some years before the Gaussian method came into general use, and especially were English scholars very slow to acquaint themselves with its merits. I have, therefore, been much interested in finding that, in 1808, Professor Robert Adrain, at that time in New Brunswick, N. J., published the method of least squares in the "Analyst," having been independently led to this invention by the study of a prize problem offered some months previously in that periodical.

As the editor of, and chief contributor to, the Mathematical Correspondent, the Analyst, and the Mathematical Diary, and as Professor in Columbia College and in Pennsylvania University, as well as by his correspondence, Dr. Adrain is well known to have contributed powerfully to the progress of Mathematical studies in this his adopted country—(he was born and educated in Dublin)—and his apparently independent demonstration of the method of least squares seems quite in accordance with the originality shown in many other of the elegant solutions offered by him to the different problems on which he busied himself. A number of interesting and probably valuable mathematical manuscripts still remain in the possession of his family at New Brunswick, New Jersey, which it is to be hoped may some day see the light. At present I would offer toward the history of mathematics in America the following extracts from the Analyst and other publications.

The problem "to correct the distances and bearings of a survey, so as to deduce the most probable area of the enclosed field," had been proposed by Professor Patterson in a previous number of the Analyst, and after being a second time renewed as a prize question, was at length in number IV, solved by a course of special reasoning, by Dr. Bowditch, to whom Dr. Adrain awarded the prize. Dr. Bowditch's results coincided with what would have been deduced had the Gaussian method been applied to this case. Immediately following Dr. Bowditch's special solution, the editor adds his own solution of the more general problem as follows: (The Analyst, pp. 93–95 inclusive).

"*Research concerning the probabilities of the errors which happen in making observations.*"

"The question which I propose to resolve is this: supposing AB to be the true value of any quantity of which the measure by observation or experiment is A*b*, the error being B*b*; what is the expression of the probability that the error B*b* happens in measuring AB?

Let AB, BC, &c., be several successive distances of which the values by measure are A*b*, *bc*, &c., the whole error being C*c*; now supposing the measures A*b*, *bc*, to be given and also the whole error C*c*, we assume as a self-evident principle, that the most probable distances AB, BC are proportional to the measures A*b*, *bc*; and therefore the errors belonging to AB, BC are proportional to their lengths, or to their measured values A*b*, *bc*. If therefore we represent the values of AB, BC or of their measures A*b*, *bc* by $a$, $b$, the whole error C*c* by C, and the errors of the measures A*b*, *bc* by $x$, $y$, we must for the greatest probability, have the equation $\frac{x}{a} = \frac{y}{b}$. Let X and Y be similar functions of $a$, $x$, and of $b$, $y$, expressing the probabilities that the errors $x$, $y$ happen in the distances $a$, $b$; and, by the fundamental principle of the doctrine of chance, the probability that both these errors happen together will be expressed by the product XY. If now we were to determine the values of $x$ and $y$ from the equations $x+y=\mathrm{E}$ and $\mathrm{XY}=\text{maximum}$, we ought evidently to arrive at the equation $\frac{x}{a}=\frac{y}{b}$: and since $x$ and $y$ are rational functions of the simplest order possible of $a$, $b$ and E, we ought to arrive at the equation $\frac{x}{a}=\frac{y}{b}$ without the intervention of roots, in other words by simple equations; or, which amounts to the same thing in effect, if there be several forms of X and Y that will fulfill the required condition we must choose the simplest possible, as having the greatest possible degree of probability.

"Let X′, Y′ be the logarithms of X and Y, to any base or modulus; and when $\mathrm{XY} = max.$ its logarithm $\mathrm{X}' + \mathrm{Y}' = max.$ and therefore $\dot{\mathrm{X}}' + \dot{\mathrm{Y}}' = 0$, which fluxional equation we may express by $\mathrm{X}''\dot{x} + \mathrm{Y}''\dot{y} = 0$; for as X′ involves only the variable quantity $x$, its fluxion $\dot{\mathrm{X}}'$ will evidently involve only the fluxion of $x$; in like manner the fluxion of Y′ may be expressed by $\mathrm{Y}''\dot{y}$; and from the equation $\mathrm{X}''\dot{x} + \mathrm{Y}''\dot{y} = 0$ we have $\mathrm{X}''\dot{x} = -\mathrm{Y}''\dot{y}$: but since $x + y = \mathrm{E}$ we have also $\dot{x} + \dot{y} = 0$, and $\dot{x} = -\dot{y}$, by which dividing the equation $\dot{\mathrm{X}}''\dot{x} = -\dot{\mathrm{Y}}''\dot{y}$, we obtain $\mathrm{X}'' = \mathrm{Y}''$.

"Now this equation ought to be equivalent to $\frac{x}{a} = \frac{y}{b}$; and this circumstance is effected in the simplest manner possible, by assuming $\mathrm{X}'' = \frac{mx}{a}$, and $\mathrm{Y}'' = \frac{my}{b}$; $m$ being any fixed number which the question may require.

"Since, therefore, $\mathrm{X}'' = \frac{mx}{a}$ we have $\mathrm{X}''\dot{x} = \dot{\mathrm{X}}' = \frac{mx\dot{x}}{a}$, and taking the fluent, we have $\mathrm{X}' = a' + \frac{mx^2}{2a}$. The constant quantity $a'$ being either absolute, or some function of the distance $a$.

"We have discovered, therefore, that the logarithm of the probability that the error $x$ happens in the distance $a$ is expressed by $a' + \frac{mx^2}{2a} = \mathrm{X}'$, and consequently the probability itself is $\mathrm{X} = e^{\mathrm{X}'} = e^{\left(a' + \frac{mx^2}{2a}\right)}$. Such is the formula by which the probabilities of different errors may be compared, when the values of the determinate quantities $e$, $a'$ and $m$ are properly adjusted. If this probability of the error $x$ be denoted by $u$, the ordinate of a curve to the abscissa $x$, we shall have $u = e^{\left(a' + \frac{mx^2}{2a}\right)}$, which is the general equation of *the curve of probability.*

"When only the maximum of probability is required, we have no need of the values of $e$, $a'$ and $m$; it is proper, however, to observe that $m$ must be negative. This is easily shown. The probability that the errors $x$, $y$, $z$, etc., happen in the distances $a$, $b$, $c$, etc., is $e^{\left(a' + \frac{mx^2}{2a}\right)} \times e^{\left(b' + \frac{my^2}{2b}\right)} \times e^{\left(c' + \frac{mz^2}{2c}\right)}$, etc., which is equal to $e^{\left(a' + b' + c', \text{ etc.}, + \frac{mx^2}{2a} + \frac{my^2}{2b} + \frac{mz^2}{2c}, \text{ etc.}\right)}$, and this quantity will evidently be a maximum or minimum as its index or logarithm is a maximum or minimum; that is, when

$$\frac{m}{2}\left\{\frac{x^2}{a} + \frac{y^2}{b} + \frac{z^2}{c}, \text{ etc.,}\right\} = \text{a maximum or minimum.}$$

Now when $x + y + z$, etc., $=$ E, we know that

$$\frac{x^2}{a} + \frac{y^2}{b} + \frac{z^2}{c}, \text{ etc.,} = \text{minimum, when } \frac{x}{a} = \frac{y}{b} = \frac{z}{c}, \text{ etc.,}$$

and therefore $-\left\{\frac{x^2}{a} + \frac{y^2}{b} + \frac{z^2}{c}, \text{ etc.,}\right\} = \text{maximum.}$

When $\frac{x}{a} = \frac{y}{b} = \frac{z}{c}$, etc., it is evident therefore that $m$ must be negative; and as we may for the case of maxima use any value of it we please, we may put $m = -2$, and the probability of $x$ in $a$ is $u = e^{\left(a' - \frac{x^2}{a}\right)}$. If we put $\frac{m}{2a} = -1$ and $a' = f^2$, we have $u = e^{(f^2 - x^2)}$ for the equation of the curve of probability; but if we suppose $f^2 = 0$, the ordinates $u$ will still be proportional to their former values, and we shall have $u = e^{-x^2}$, or $u = \frac{1}{e^{x^2}}$, which is the simplest form of the equation expressing the nature of the curve of probability."

Immediately following the above general solution by Dr. Adrian there are given applications of this method to the following problems.

1. To find the most probable value of any quantity of which a number of direct measures are given.
2. To find a most probable position of a point in space.
3. To correct in the most probable manner the dead reckoning at sea.
4. To correct the bearing and distances of a field survey.

The article closes on p. 109 of the Analyst with the following: "I have applied the principles of this essay to the determination of the most probable value of the earth's ellipticity, &c., but want of room will not permit me to give the investigation at this time."

The investigations here alluded to were, however, long afterwards published, i. e., in 1817, in vol. i, new series, of the Transactions of the American Philosophical Society, and are given in two papers (Nos. IV and XXVIII) of that volume. The preceding note as well as the dates written on the manuscripts (which are still preserved by the Hon. G. B. Adrian of New Brunswick) show that these two investigations were completed in 1808.

The first of the papers here alluded to is entitled "Investigation of the figure of the earth and of the gravity in different latitudes," from which as printed in the Phil. Trans., we make the following extract:

"Having in the year 1808 discovered a general method of resolving several useful problems by ascertaining the highest degree of probability, when certainty cannot be found, I shall here apply that method to the determining of the earth's ellipticity, &c." The author's computation is based on the lengths of the seconds pendulum as given by Laplace (Mec. Cel., iii), and having stated the problem before him, he says: "This is accomplished by a rule published by the writer in the Analyst, in 1808." The resulting ellipticity ($\frac{1}{319}$) he shows to differ from that deduced by Laplace ($\frac{1}{376}$) because of numerical errors in the computation of the latter; having corrected these he deduces the ellipticity $\frac{1}{319 \cdot 5}$ by Laplace's own method—showing that the two methods conduce to nearly the same result.

The second of the articles in the Phil. Trans., is entitled "A Research concerning the Mean Diameter of the Earth." In this the author seeks the sphere which most nearly coincides in various specified peculiarities with the actual terrestrial spheroid; the diameter of this sphere he determines to be 7918·7 miles. This numerical result is based upon some earlier computations, the details of which are not given, but of which he says: "Having determined the most probable axis of the terrestrial spheroid from the measurements of a degree of the meridian by a method which I discovered several years ago and published in the Analyst, the resulting mean radius was found to be 3959·69 English miles."

The mathematical works published by Dr. Adrian are so rarely to be met with, that it was necessary to make these long extracts in order to establish the conclusion to which we have arrived, i. e., that we must credit Dr. Adrian with the independent invention and application of the most valuable arithmetical process that has been invoked to aid the progress of the exact sciences.

***Washington, Feb. 22, 1871.***

## ART. LX.—*Contributions to Chemistry from the Laboratory of the Lawrence Scientific School.* No. 15.—*On some new Analytical Methods;* by THOMAS M. CHATARD.

### § 1. *On the Determination of Molybdic Acid as Plumbic Molybdate.*

GREAT difficulty has always been experienced in determining molybdenum by any of the methods generally in use. The precipitation as mercurous molybdate, and the subsequent treatment, are both tedious and unsatisfactory, and an accurate determination as sulphide is almost impossible, the filtrate remaining blue even after repeatedly passing sulphydric acid and filtering.

The following method will, I hope, be found to give satisfaction, both as to ease of working and accuracy of results.

Add to the boiling solution of the molybdate, plumbic acetate in slight excess. Boil for a few minutes; the precipitate, at first milky, will become granular and will subside easily, leaving a perfectly clear supernatant liquid. Care must be taken in boiling, as the thick milky fluid is very apt to boil over. A ribbed filter is to be used and the precipitate is to be washed with hot water. The washing proceeds with great ease and thoroughness, and not the slightest milkiness should be apparent in the filtrate. The precipitate is dried at 100°, separated from the filter and ignited in a porcelain crucible.

The results were as follows:

1·0744 grm. $Na_2MoO_4$ gave 1·9176 grm. $PbMoO_4$ = 46·64 p. c. Mo.
1·4440 " " " " 2·5738 " " = 46·60 " "
1·2221 " " " " 2·1811 " " = 46·66 " "
1·2871 " " " " 2·2999 " " = 46·74 " "
Mean = 46·66.

The theoretical percentage of Mo in $Na_2MoO_4$ is 46·60 if Mo = 96, this being the number given by the most recent determinations.

The process seems therefore to give very good quantitative results, and is both easy and expeditious. The precipitated molybdate separates easily from the filter and can be heated to low redness without decomposition.

Analogy would seem to offer a good method for tungstic acid and experimental analyses were made for this purpose, but after repeated trials the process was finally abandoned, as the precipitate came down so finely divided that it passed through the filter. The precipitation seems, however, to be complete, and I have hopes that with closer filter paper greater success will be obtained.

Attempts were made to determine arsenic as arsenate of lead but without good quantitative results. On the other hand

I tried to determine lead as molybdate, tungstate, and arsenate, but without success, as the presence of an excess of the precipitant in such cases seems to exert an injurious effect, the filtrate or washings speedily becoming cloudy.

It may not be out of place to mention some work upon molybdenum undertaken some time ago, which, though unsuccessful, is not without interest. Various methods were devised of weighing the molybdenum as sulphide.

One way was to precipitate molybdic acid as mercurous molybdate in the usual manner. The suspended molybdate was boiled and sulphydric acid passed into the boiling liquid.

The mercurous molybdate was decomposed and mercurous sulphide and molybdic sulphide were the results. The sulphides were thrown upon a filter and washed with cold sulphydric acid water, dried and ignited in a current of sulphydric acid, but this process failed to give satisfactory results.

Again, sodic molybdate was heated with four parts of dry sodic hyposulphite till all the free sulphur was driven off, leaving, according to theory, $Na_2SO_4+MoS_3$. The mass was then digested with hot water, filtered and treated as before. When any of the sulphur was left, it was found that some of the molybdenum went into solution as sulphomolybdate of sodium. Even after adopting every precaution, enough was still dissolved to vitiate the analysis.

## § 2. *On the Evaporation to dryness of Gelatinous Precipitates.*

In a former paper* I called attention to the fact that many gelatinous precipitates, when evaporated to dryness, became very granular and easy to filter. I gave some examples then and have since tested several others.

*Titanic Acid.*—Rutile was fused with sodic disulphate, the titanic acid precipitated by ammonic hydrate and evaporated to dryness. It became quite sandy and washed with great rapidity and thoroughness.

*Glucina.*—Pure glucina was dissolved in chlorhydric acid, precipitated by ammonic hydrate and evaporated to dryness. In this case as glucina is soluble in ammoniacal salts, it was necessary to ignite the dry mass to expel these. This was done in the platinum dish in which the evaporation was carried on. The residual glucina was sandy and washed with great ease; *zirconic*, *niobic* and *tantalic acids* when thus treated gave results which were all that could be desired.

Ceric, lanthanic and didymic oxalates when treated with sulphuric acid, and ammonic hydrate added, gave also perfectly satisfactory results.

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* This Journal, vol. l, p. 247.

In conclusion, there seems to be no doubt that almost any gelatinous precipitate can be successfully treated in this manner.

### § 3. *Tests for Nitrous Acid.*

During the course of some work on the nitrites of nickel and cobalt, it was necessary to have an easy and accurate test for nitrous acid. I therefore reviewed all the tests given for that acid, comparing their relative degrees of delicacy, with the following results. For testing, a very dilute solution of Fischer's salt, ($Co_2 6NO_2 + 6(KNO_2) + 2Aq$), which contained $\frac{1}{300000}$ part by weight of nitrous acid, was employed.

Schönbein's[*] test with a weak solution of indigo decolorized by potassic sulphide failed to give accurate results. Besides there are many substances which would have the same action upon the decolorized indigo as the nitrous acid.

C. D. Braun's[†] test with cobaltous chloride and potassic cyanide gave no reaction with so dilute a solution, even when several cubic centimeters were taken, the reaction only appearing when a comparatively strong solution of the nitrite was used.

Hadow's[‡] reaction in which a nitrite when heated with potassic ferrocyanide and mercuric chloride forms nitroprussic acid which is detected by an alkaline sulphide, gave good results only when the nitrous acid was present in larger quantities, not being delicate enough to give a reaction with the standard solution of nitrite which I employed.

A modification of this test suggested itself, in which the nitroprussic acid is thus produced. To the solution suspected of containing the acid, potassic ferrocyanide and acetic acid are added, and the whole boiled. The solution is allowed to cool, and ammonic sulphide added. If nitrous acid was originally present, the characteristic blue reaction will appear. 10 c.c. of the test solution gave the reaction, but it failed with a smaller quantity.

The problem was finally solved by another reaction, namely, the production of phenol from aniline by means of nitrous acid. Evaporate the test liquid nearly to dryness, then rub it with a few drops of a strong solution of sulphate of aniline. If nitrous acid is present the odor of phenol will immediately result. This test is remarkably delicate, 1 c. c. of the test solution giving a perfectly distinct reaction. Nor can nitrous be confounded with nitric acid, as this last produces no phenol, but merely a yellow color, which of itself, as is well known, is of value as a test for that acid.

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[*] Jahresbericht, 1864, 699.

[†] Ibid. 1865, 702.

[‡] Jour. Chem. Soc., vol. iv, p. 341.

### § 4. *On the Determination of small quantities of Manganese.*

The delicacy of Crum's test for manganese is well known, but it is believed that no attempt has hitherto been made to employ it as a method of quantitative determination. The following work was, therefore, undertaken with that view.

A standard solution of ammonic oxalate was prepared, of which 1 c. c.=0·0005467 grm. Mn. A sample of dolomite was taken, and four portions were weighed out. These were dissolved in nitric acid, and a small quantity of plumbic peroxide added to each. On boiling, the bright color of hypermanganic acid appeared. The solutions were passed through small filters of asbestos with the aid of a Bunsen's pump, and the hypermanganic acid was determined by means of a standard solution of ammonic oxalate with the following results:

3·1300 grm. dolomite required 39·0 c. c. = 0·0216 grm. Mn = 00·069 p. c. Mn
2·781 " " " 33·2 " = 0·0181 " " = 00·065 " "
2·0998 " " " 24·5 " = 0·0134 " " = 00·063 " "
1·8671 " " " 23·5 " = 0·0128 " " = 00·062 " "
Mean = 00·065 p. c. Mn.

In a sample of limestone from White Horse, Chester, Co., Pa. the analysis showed

3·4316 grm. required 120 c. c. = 0 0656 grm. Mn = 1·92 p. c. Mn.
2·2809 " " 83·5 " = 0·04564 " " = 2·00 " "
4·0697 " " 153·5 " = 0·0838 " " = 2·05 " "
Mean = 1·99 p. c. Mn.

But the method, though giving good results where the percentage of manganese is small, fails when any large amount of that metal is present. Well dried manganous pyrophosphate was treated with sulphuric acid, as nitric acid, though dissolving it, was found not to decompose it, little or no hypermanganic acid being formed when the plumbic peroxide was added. With sulphuric acid, the red color of hypermanganic acid was produced, but it was found that not even long boiling sufficed for total oxydation.

This was also the case with an alloy of iron and manganese. The longer it was boiled, the more hypermanganic acid was formed, but there seemed to be no definite limit. No concordant results having been reached, and a well marked end reaction in such cases being hard to obtain, the method as applied to general analysis was given up.

There seems to be, however, reason to maintain that when the quantity of manganese is very small, the method will be found both easy and accurate. Perhaps by some modification of the process, it may be made to apply also to the cases in which large quantities of manganese are present.

In conclusion, I desire to acknowledge my indebtedness to Dr. W. Gibbs for his careful supervision and many valuable suggestions.

**Cambridge, March 1, 1871.**

## ART. LXI.—*On the Oil-bearing Limestone of Chicago;* by T. STERRY HUNT, LL.D., F.R.S.

**(Read before the American Association for the Advancement of Science at Troy, August, 1870.)**

WHEN in 1861,* I first published my views on the petroleum of the West, I expressed the opinion that the true source of it was to be looked for in certain limestone formations which had long been known to be oleiferous. I referred to the early observations of Eaton and Hall on the petroleum of the Niagara limestone, to numerous instances of the occurrence of this substance in the Trenton and Corniferous formations and, in Gaspé, in limestones of Lower Helderberg age. Subsequently, in this Journal for March, 1863, and in the Geology of Canada, I insisted still further upon the oleiferous character of the Corniferous limestone in southwestern Ontario, which appears to be the source of the petroleum found in that region. I may here be permitted to recapitulate some of my reasons for concluding that petroleum is indigenous to these limestones, and for rejecting the contrary opinion, held by some geologists, that its occurrence in them is due to infiltration, and that its origin is to be sought in an unexplained process of distillation from pyroschists or so-called bituminous shales. These occur at three distinct horizons in the New York system, and are known as the Utica slate, immediately above the Trenton limestone, and the Marcellus and Genesee slates which lie above and below the Hamilton shales; the latter being separated from the underlying Corniferous limestone by the Marcellus slate.

First, these various pyroschists do not, except in rare instances, contain any petroleum or other form of bitumen. Their capability of yielding volatile liquid hydrocarbons or pyrogenous oils, allied in composition to petroleum, by what is known to chemists as destructive distillation, at elevated temperatures, is a property which they possess in common with wood, peat, lignite, coal, and most substances of organic origin, and has led to their being called bituminous, although they are not in any proper sense bituminiferous. The distinction is one which will at once be obvious to all those who are familiar with chemistry, and who know that pyroschists are argillaceous rocks containing in a state of admixture a brownish insoluble and infusible hydrocarbonaceous matter, allied to lignite or to coal.†

Second, the pyroschists of these different formations do not, so far as known, in any part of their geological distribution, whether exposed at the surface or brought up by borings from depths of many hundred feet, present any evidence of having been submitted to the temperature required for the generation of volatile hydrocarbons. On the contrary they still retain the property of yielding such products when exposed to a sufficient heat, at the same time undergoing a charring process by which their brown color is changed to black. In other words these pyroschists have not yet undergone the process of destructive distillation.

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* Montreal Gazette, March 1, and Can. Naturalist, July, 1861.

† This Journal, II, xxxv, 159–161.

Third, the conditions which the oil occurs in the limestones, are inconsistent with the notion that it has been introduced into these rocks by distillation. The only probable or conceivable source of heat, in the circumstances, being from beneath, the process of distillation would naturally be one of ascension, the more so as the pores of the underlying strata would be filled with water. Such being the case, the petroleum of the Upper Silurian and Lower Devonian limestones must have been derived from the Utica slate beneath. This rock, however, is unaltered, and moreover, the intermediate sandstones and shales of the Loraine, Medina and Clinton formations are destitute of petroleum, which must, on this hypothesis, have passed through all these strata to condense in the Niagara and the Corniferous limestones. More than this, the Trenton limestone which, on Lake Huron and elsewhere, has yielded considerable quantities of petroleum, has no pyroschists beneath it, but on Lake Huron rests on ancient crystalline rocks, with the intervention only of a sterile sandstone. The rock-formations holding petroleum are not only separated from each other by great thicknesses of porous strata destitute of it, but the distribution of this substance is still further localized, as I many years since pointed out. The petroleum is in fact in many cases, confined to certain bands or layers in the limestone, in which it fills the pores and the cavities of fossil shells and corals, while other portions of the limestone, both above, below, and in the prolongation of the same stratum, though equally porous, contain no petroleum. From all these facts the only reasonable conclusion seems to me to be that the petroleum, or rather the materials from which it has been formed, existed in these limestone rocks from the time of their first deposition. The view which I put forward in 1861, that petroleum and similar bitumens have resulted from a peculiar "transformation of vegetable matters, or in some cases of animal tissues analogous to these in composition," has received additional support from the observations of Lesley,* in West Virginia and Kentucky, and from the more recent ones of Peckham.†

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* Rep. Geol., Canada, 1866, 240, and Proc. Amer. Philos. Soc., x, 33, 187.

† Ibid, x, 445.

The objections to this view of the origin and geological relations of petroleum have been for the most part founded on incorrect notions of the geological structure of southwestern Ontario, which has afforded me peculiar facilities for studying the question. In this region, it has been maintained by Winchell that the source of the petroleum is to be sought in the Devonian pyroschists. I however showed in 1866, as the result of careful studies of the various borings: first, that none of the oil-wells were sunk in the Genesee slates, but along denuded anticlinals where these rocks have disappeared, and where, except the thin layer of Marcellus slate sometimes met with at the base of the Hamilton shales, no pyroschists are found above the Trenton limestone. Second, that the reservoirs of petroleum in the wells sunk into the Hamilton shales are sometimes met with in this formation, and sometimes, in adjacent borings, only in the underlying Corniferous. Examples of this have been cited by me in wells in Enniskillen, Bothwell, Chatham and Thamesville, where petroleum has first been found at depths of from thirty to one hundred and twenty feet in the Corniferous limestone, in all of these places overlaid by the Hamilton shales. It was also shown, that in two localities in this region, viz., at Tilsonburg and in Maidstone, where the Corniferous is covered only by quaternary clays, petroleum in considerable quantities has been obtained by sinking into the limestone.* That the supplies of petroleum in such localities are less abundant than in parts where a mass of shales and sandstones overlies the oil-bearing limestone is explained by the fact that both the pores and the fissures in the superior strata serve to retain the oil, in a manner analogous to the quaternary gravels in some parts of this region, which are the sources of the so-called surface oil-wells. It is, therefore, not surprising that examples of pyroschists impregnated with oil should sometimes occur, but the evidence of the existence of indigenous petroleum, which is so clear in the various limestones, is wanting in the case of the pyroschists; although concretions holding petroleum, have been observed in the Marcellus and the Genesee slates of New York. There is, however, reason to believe, as I have elsewhere pointed out, that much of the petroleum of Pennsylvania, Ohio, and the adjacent regions, is indigeneous to certain sandstone strata in the Devonian and Carboniferous rocks.†

At the meeting of the American Association for the Advancement of Science at Chicago, in August, 1868, in a discussion which followed the reading of a paper by myself on the geology of Ontario,‡ it was contended that, although the various limestones which have been mentioned are truly oleiferous, the quantity of petroleum which they contain is too inconsiderable to account for the great supplies furnished by oil-producing districts, like that of Ontario for example. This opinion being contrary to that which I had always entertained, I resolved to submit to examination the well-known oil-bearing limestone of Chicago.

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* This Jour. II, xlvi, 360; and Report Geol., Canada, 1866, pp. 241–250.

† Ibid. 240.

‡ This Jour. II, xlvi, 355.

This limestone, the quarries of which are in the immediate vicinity of the city, is so filled with petroleum that blocks of it which have been used in buildings are discolored by the exudations, which mingled with dust, form a tarry coating upon the exposed surfaces. The thickness of the oil-bearing beds, which are massive and horizontal, is, according to Prof. Worthen, from thirty-five to forty feet, and they occupy a position about mid-way in the Niagara formation, which has in this region a thickness of from 200 to 250 feet. As exposed in the quarry, the whole rock seems pretty uniformly saturated with petroleum, which exudes from the natural joints and the fractured surfaces, and covers small pools of water in the depressions of the quarry. I selected numerous specimens of the rocks from different points and at various levels, with a view of getting an average sample, although it was evident that they had already lost a portion of their original content of petroleum. After lying for more than a year in my laboratory they were submitted to chemical examination. The rock, though porous and discolored by petroleum, is, when freed from this substance, a nearly white, granular, crystalline and very pure dolomite, yielding 54·6 p. c. of carbonate of lime.

Two separate portions, each made up of fragments obtained by breaking up some pounds of the specimens above mentioned, and supposed to represent an average of the rock exposed in the quarry, were reduced to coarse powder in an iron mortar. Of these two portions, respectively, 100 and 188 grammes were taken, and were dissolved in warm dilute hydrochloric acid. The tarry residue which remained in each case, was carefully collected and treated with ether, in which it was readily soluble with the exception of a small residue. This, in one of the samples, was found equal to ·40 p. c., of which ·13 was volatilized by heat with the production of a combustible vapor having a fatty odor; the remainder was silicious. The brown etherial solutions were evaporated, and the residuum, freed from water and dried at 100° C., weighed in the two experiments equal to 1·570 and 1·505 per cent of the rock, or a mean of 1·537. It was a viscid reddish-brown oil, which, though deprived of its more volatile portions, still retained somewhat of the odor of petroleum, which is so marked in the rock. Its specific gravity, as determined by that of a mixture of alcohol and water, in which the globules of the petroleum remained suspended, was ·935 at 16° C. Estimating the density of the somewhat porous dolomite at 2·600, we have the equation ·935 : 2·600 : : 1·537 : 4·26; so that the volume of the petroleum obtained equalled 4·26 per cent of the rock. This result is evidently too low for two reasons; first, because the rock had already lost a part of its oil, while in the quarry and subsequently, before its examination: and secondly, because the more volatile portions had been dissipated in the process of extraction just described.

In assuming 100·00 parts of the rock to hold 4·25 parts by volume of petroleum, we are thus below the truth in the following calculations. A layer of this oleiferous dolomite one mile (5280 feet) square, and one foot in thickness will contain 1,184,832 cubic feet of petroleum, equal to 8,850,069 gallons of 231 cubic inches, and to 221,247 barrels of forty gallons each. Taking the minimum thickness of thirty-five feet, assigned by Mr. Worthen to the oil-bearing rock at Chicago, we shall have in each square mile of it 7,743,745 barrels, or in round numbers seven and three quarter millions of barrels of petroleum. The total produce of the great Pennsylvania oil-region for the ten years from 1860 to 1870 is estimated at twenty-eight millions of barrels of petroleum, or less than would be contained in four square miles of the oil-bearing limestone band of Chicago.

It is not here the place to insist upon the geological conditions which favor the liberation of a portion of the oil from such rocks, and its accumulation in fissures along certain anticlinal lines in the broken and uplifted strata. These points in the geological history of petroleum were shown by me in my first publications already referred to, March and July, 1861, and independently, about the same time, by Prof. E. B. Andrews in this Journal for July, 1861.*

The proportion of petroleum in the rock of Chicago may be exceptionally large, but the oleiferous character of great thickness of rock in other regions is well established, and it will be seen from the above calculations that a very small proportion of the oil thus distributed would, when accumulated along lines of uplift in the strata, be more than adequate to the supply of all the petroleum wells known in the regions where these oil-bearing rocks are found. With such sources existing ready formed in the earth's crust, it seems to me, to say the least, unphilosophical to search elsewhere for the origin of petroleum, and to imagine it to be derived by some unexplained process from rocks which are destitute of the substance.

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* This Journal II, xxxii, 85. See also papers on the subject by him and by Prof. Evans, Ibid. II, xl, 33, 334; and one by the author, II, xxxv, 170; also Report Geol. Survey of Canada, 1866, pp. 256–257.

## ART. LXII.—*On the Geology of the Delta, and the Mudlumps of the Passes of the Mississippi;* by EUG. W. HILGARD.

[Continued from page 368.]

*Origin of the Mudlumps.*—The causes which give rise to the formation of mudlumps have been to some extent discussed by Sidell, Thomassy, and Lyell (*loc. cit.*). The former is inclined to ascribe the upheaval *chiefly* to the pressure of gas formed in the decay of driftwood and the like, buried in the river deposits. Thomassy resorts to the hypothesis of the existence of subterraneous channels communicating with the river, or with equally hypothetical reservoirs of water, far above; while Lyell ascribes the bulging of the bottom to the pressure of newly formed deposits upon a substratum of yielding mud, accompanied, and aided incidentally only, by the evolution of marsh gas in the decay of organic matter. I myself, having become aware of the existence of a strong artesian water pressure in the littoral formations of the Gulf, was inclined to ascribe the origin of the upheaving force to that source; and my visit to the mouths had for its object mainly, the comparison of the facts with each of the three admissible hypotheses, that of Thomassy being too fanciful to be seriously entertained.

As already stated, I at once found that the evolution of gas in the active vents was too insignificant to be considered as the cause of the rising of the liquid mud, which so greatly exceeded it in bulk, that the ascensional force of the bubbles, especially in so wide a vent-tube, would be utterly inadequate to balance the downward tendency of so heavy a liquid. It might still be alleged, in favor of the gas-hypothesis, that its pressure might be exerted statically upon the surface of the mass of liquid mud covered by impervious strata; but it is obvious that in such a case, the gas itself, necessarily accumulating at the highest, and therefore weakest, points, of the superincumbent mass, would be much more likely to break through by itself, promptly exhausting its force and quantity at any one point. No such rushing outbreaks of gas have ever been recorded, save in the case of blowing up of a lump with gunpowder; and, as Lyell remarks, this view renders inexplicable the occurrence of lumps exclusively about the mouths of the passes.

The latter objection applies equally to the hypothesis of the artesian origin of mudlump force, unless upon the (unproved) supposition that the excavation of the river channel might have rendered the outbreak of the artesian water easier there than elsewhere. But instead of *excavating*, the Mississippi has for a long time past always thrown *shallows* in advance of its mouths; and unless it were conclusively proven that *the matters ejected by the mud-springs* were such as could not originate in the present delta formation, the artesian hypothesis must lose all show of probability. An accurate investigation of the matters in question, solid, liquid, and gaseous, was therefore indicated. A few specimens for this purpose were collected for me by Mr. Marindin, in 1867; but the perusal of his report accompanying them convinced me that a personal examination *in loco* could alone insure a perfect certainty as to their significance, and accordingly, in the autumn of the same year, I re-collected specimens from the same, as well as from other localities. Very unfortunately, the arrangements for gas analysis at my command were so imperfect that, while waiting for their improvement, the gas specimens were so vitiated by diffusion through corks and wax as to render them useless; and I have been unable to replace them as yet, but hope to do so in the near future.

*Mudlump Gases.*—The examination of the water and mud seemed, however, most likely to conduce to a solution ot the problem, at any rate; for after all, the only information which could be furnished by gas analysis would be to indicate, by the greater or less amount of carbonic acid present, whether the gas originated from matter comparatively fresh and in its first stage of decomposition, or had its source in materials far advanced toward the stage of lignite or coals. The only perfectly reliable determination made was that of the carbonic acid contained in the gas collected from the most easterly active cone on Marindin's Lump, Passe à l'Outre, the rest of the determinations being somewhat vitiated, though doubtless very nearly correct.[*] The result was as follows:

*Gas from East Crater, Marindin's Lump, Passe à l' Outre.*

| | |
|---|---|
| Carbonic acid, | 9·41 |
| Marsh gas, | 86·20 |
| Nitrogen, | 4·39 |
| | 100·00 |

Oxygen was not present.

The percentage of carbonic acid in this gas is very unusually large; its composition is nearest to that of the gas from common swamps, where vegetable matter is in its first stages of decay. The proportion between marsh gas and nitrogen is nearly the same as in the gas from the gas wells at New Orleans (see p. 245): but there is three times as much carbonic acid present in the mud-lump gas, in accordance with the presumable more advanced stage of decay existing in the former locality.

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[*] After the explosion in the eudiometer, some nitrate of mercury was observed on its walls, in consequence of inadequate dilution of the gas. But the marsh gas was estimated from the carbonic acid absorbed after the explosion, the nitrogen by difference.

*Mudlump Spring Waters.*—In taking specimens, common quart bottles were filled by immersion in the craters themselves, and immediately sealed. The liquid mud thus obtained would, after a while, separate into a lower stratum of pretty solid mud, and an upper one of clear water, in varying proportions. For analysis, the latter was carefully decanted, and the turbid part rapidly filtered through a Bunsen's pressure filter, and measured. 400 ccm. were then boiled to precipitate carbonates and silica, the filtrate re-diluted to the original bulk, and from 50 to 100 ccm. used in the determination, in separate portions, of chlorine, of lime and magnesia, and of sulphuric acid and alkalies, respectively; while a fourth portion served for an approximate determination of the solid residue, for the sake of roughly controlling the final results.*

I give below, in tabular form, the results of these analyses; presented in three different forms, for the sake of ready comparison with the composition of sea-water, from which they seem to be derived by a series of reactions easily understood from the nature and condition of the materials with which they are associated.

I. Water from the basin of a spring on a mudlump off Stake Island, Southwest Pass. Evolves gas and water in about equal proportions, no mud, but only fine sandy matter; and water flows off clear over the rim of the basin, which is two feet above tide level, and at the foot of a large extinct cone with a lagoon, surrounded by a high rim, in the center.

Water about ½ of the bulk in bottle, the rest fine sand. Taste, very salty; color, slightly yellowish; turns brownish turbid very quickly on exposure to air. Coll. Dec. 3, 1867.

II. Water from a mudlump spring on Northeast Pass, collected by H. L. Marindin, of U. S. Coast Survey schr. Varina, in February, 1867.

According to the recollection of one of the crew, this specimen was taken from the same cone as the following one (No. III).

Water clear, faintly yellowish, about ½ by bulk of the contents; the rest sandy mud. Turns turbid rapidly on exposure to air.

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* With mixtures of this kind no method but that of evaporation with excess of carbonate of soda will yield anything more than an approximate estimate of the solid residue; involving an amount of labor and care not always justified by the end in view, when the relative amounts of ingredients can serve to control. The chlorine determination being the most accurate, and almost always in excess of the bases found available to form chlorides, the chloride of sodium, as here recorded, is the *calculated* amount, as is also the sum of ingredients.

*Analyses of Waters from Mudlump Springs, Mississippi Passes.*

| | Southwest Pass. | | | Northeast Pass. Salt Spring Island. | | | | | | Passe à l'Outre. Marindin's Lump. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | February. | | | December. | | | East Crater. | | | West Crater. | | |
| | I. | | | II. | | | III. | | | IV. | | | V. | | |
| | a. | b. | c. | a. | b. | c. | a. | b. | c. | a. | b. | c. | a. | b. | c. |
| Chloride of Sodium, | 2·5374 | 80·060 | 81·662 | 2·7847 | 81·937 | 84·117 | 2·7751 | 82·809 | 84·670 | 1·2439 | 79·094 | 85·857 | 1·7544 | 79·708 | 84·055 |
| " Potassium, | 0·0280 | 0·884 | 0·901 | 0·0441 | 1·297 | 1·332 | 0·0441 | 1·316 | 1·346 | | | | 0·0166 | 0·754 | 0·795 |
| " Calcium, | 0·0725 | 2·287 | 2·388 | 0·0342 | 1·006 | 1·033 | 0·0638 | 1·903 | 1·947 | 0·0018 | 0·114 | 0·124 | 0·0649 | 2·947 | 3·109 |
| " Magnesium, | 0·4635 | 14·624 | 14·917 | 0·4475 | 13·168 | 13·518 | 0·3945 | 11·773 | 12·037 | 0·1962 | 12·475 | 13·543 | 0·1259 | 11·440 | 12·061 |
| Sulphate of Calcium, | 0·0007 | 0·022 | 0·023 | | | | | | | 0·0069 | 0·439 | 0·476 | | | |
| " Magnesium, | | | | | | | | | | | | | | | |
| Carbonate of Calcium, | 0·0011 | 0.035 | | 0·0313 | 0·921 | | 0·0001 | 0·003 | | 0·0695 | 4·419 | | 0·0230 | 1·045 | |
| " Magnesium, | 0·0446 | 1.407 | | 0·0447 | 1·315 | | 0·0724 | 2·160 | | 0·0392 | 2·492 | | 0·0745 | 3·385 | |
| " Iron, | 0·0158 | 0.499 | | 0·0121 | 0·356 | | | | | 0·0119 | 0·757 | | 0·0128 | 0·582 | |
| Silica, | 0·0007 | 0.022 | | | | | 0·0012 | 0·036 | | 0·0033 | 0·210 | | 0·0030 | 0·139 | |
| | 3·1643 | 99·840 | 99·891 | 3·3986 | 100·000 | 100·000 | 8·3512 | 100·000 | 100·000 | 1·5727 | 100·000 | 100·000 | 2·2010 | 0·06100 | 100·000 |
| Specific Gravity, | | 1·02388 | | | 1·0244 | | | | | | 1·01196 | | | 1·01689 | |

a. Ingredients in 100 ccm. of the water. b. Ingredients in 100 parts of solid residue. c. Ingredients in 100 parts of solid residue exclusive of carbonates and silica.

**TABLE—continued.**

| | Knight's Gas Well. New Orleans. VI. | | | Gulf Water. 30 miles out. VII. | | Sea Water. Average composition. VIII. | |
|---|---|---|---|---|---|---|---|
| | a. | b. | c. | a. | b. | a. | b. |
| Chloride of sodium, | 0·02310 | 37·880 | 56·479 | 1·6723 | 76·870 | 2·700 | 77·032 |
| " potassium, | 0·00790 | 12·950 | 19·315 | 0·0357 | 1·640 | 0·070 | 1·997 |
| " calcium, | 0·00060 | 0·980 | 1·467 | | | | |
| " magnesium, | 0·00630 | 10·330 | 15·404 | 0·2310 | 10·620 | | 10·271 |
| Sulphate of calcium, | | | | | | | |
| | | | | | | 0·360 | |
| Bromide of magnesium, | | | | trace. | trace. | 0·002 | 0·058 |
| Sulphate " | 0·00300 | 4·920 | 7·335 | 0·1077 | 4·950 | 0·140 | 3·994 |
| | | | | 0·1289 | 5·920 | 0·230 | 6·562 |
| Carbonate of calcium, | 0·01120 | 18·360 | | | | 0·003 | 0·086 |
| " magnesium, | 0·00760 | 12 450 | | | | | |
| " iron, | | | | | | | |
| Silica, | 0·00130 | 2·130 | | | | | |
| | 0·06100 | 100·000 | 100·000 | 2·1756 | 100·000 | 3·505 | 100·000 |
| Specific gravity, | | | | 1·01630 | | 1·0298 | |

III. Water from faintly active cone on Salt Spring Island, off Northeast Pass; from crater on west side of island, about ten feet above sea-level. Collected Dec. 2, 1867.

Water very salty, about ¾ of the whole mass; the rest, a somewhat sandy mud; color, slightly yellowish; turns turbid rapidly on exposure to air.

The larger proportion of water in this specimen, as compared with the preceding, doubtless results from the comparative inactivity of the cone, as compared to that at the time of high water in February. The same fact may account for some of the difference in composition.

IV. Water from East Crater on Marindin's Lump, Passe à l'Outre. See p. 362. Collected Dec. 2, 1867.

Forms about ⅗ of the bulk in the bottle, the rest is soft clayey mud. Faintly brownish, clear; becomes brownish turbid rapidly on exposure to air.

V. Water from West Crater on Marindin's Lump, Passe à l'Outre; same date.

Water about ¼ of bulk in bottle, the rest clayey mud. Not very salty; colorless, but turns turbid quickly on exposure to air.

VI. Water from gas well bored by J. B. Knight, at New Orleans. Clear, with a little sand at bottom; taste, faintly brackish.

VII. Water of the Gulf of Mexico, taken from surface 30 miles out, southeast from Southwest Pass, Dec. 1867.

VIII. Average composition of sea-water, according to Regnault.

The general results deducible from the above analyses may be thus stated:

1. There is a general similarity of composition between the waters of the mudlump springs, indicating their derivation from a common source of supply. But springs on the same lump, as well as the same spring at different times or stages of water, may vary quite sensibly, both in composition and concentration. Their density is generally inferior to that of sea-water, though at times approaching it closely.

2. There is an obvious approximation of the ratio between the two chief bases—sodium and magnesium—to that existing in sea-water; the variations being no greater than are observed in sea-water from different localities.

3. The most obvious difference is the absence of sulphates, and their partial replacement by chlorides; also

4. The presence of large amounts of the carbonates of the earths, as well as of iron, dissolved in carbonic acid.

5. The amount of potassium salts is decidedly diminished.

6. Bromids appear to be entirely absent, and are present in traces only, in the water of the Gulf itself.

It is stated that the waters of some of the springs are fresh. I have found all brackish *at least*, and as the population of the delta is much in the habit of drinking water of questionable freshness, their judgment in the matter may not be the most reliable.

As regards the water of the New Orleans well, though at first sight it differs materially from the others, it will be observed that when in C, potassium and sodium chlorides are classed together, its composition becomes not unlike the mudlump waters. Its great dilution accounts for the excessive proportion of carbonates.

The Gulf water approaches very closely in its composition to the normal one of sea-water, as given by Regnault.

*Mud from Mudlump Springs.*—I have already stated, that the stratified material of the mudlumps (whether formed by the action of mud springs, or bodily upheaved) is free from visible shells or other fossils, save particles of woody matter; while the amorphous material which forms the surface and generally also the beach, often abounds in such organic remains as are now usually washed ashore, having manifestly been *cast* up and imbedded in the mud by the waves.

I have examined microscopically the mud remaining in the specimen bottles after decanting the water for analysis; they were immediately refilled with distilled water, and kept closely stopped until examined. I give below the record of examination of the mud, corresponding to analysis No. V, from West Crater on Marindin's Lump. Two or three others similarly examined gave a like result.

A sample from the general mass shows it to consist mainly of very fine quartz sand, mostly angular, with but a few large, angular grains; and but little true clay.

In washing the mass, even the first washings were found to contain but little clay, but chiefly very fine suspended silex. A few ill defined spicules, a Navicula, and bark fibers.

In the middle portion, spicules a little more abundant.

In the coarsest portion, much variously colored mica, along with, mostly sharply angular, quartz grains; numerous particles of water-browned wood; very distinct spine of a radiate; several specimens of Rotalina, and fragments of same as well as Uvigerina, Cristellaria, Amphistegina, and Coccineis? Also iridescent fragments, showing lines of growth, from the edges of larger bivalves.

Quartz grains mostly transparent and angular; some of milky, oil-green, and rose quartz; these mostly rounded. This sand resembles closely that of the bottom outside Northeast Pass bar, in 40 to 50 feet water; specimens of which were furnished me by the Coast Survey party, under command of Capt. F. V. Webber of the schooner Varina, in 1869.

Specimens from mudlumps on Southwest Pass show coarser sand, and rather more Foraminifera.

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The character of the materials ejected by the mudlump springs, as determined by the foregoing investigations, may be summed up as follows:

1. The *gas* is such as is evolved by vegetable matter in its *first* stages of decay or lignitization.

2. The *earthy matter* contains both river and marine fossils—driftwood reduced almost to its cell-elements by maceration and trituration, as well as Foraminifera. Its fineness is such that, before final deposition, it may have been carried out into water of considerable depth.

3. The mudlump waters appear to be sea-water more or less diluted, and chemically changed under the joint influence of fermenting organic matter, and the more active ingredients of the river deposit, viz: carbonates of lime and magnesia, and oxide of iron.

The first effect thus produced would probably be the addition of the soluble carbonates of these metals to the solution. But the soluble sulphates could not, in the presence of a soluble iron salt, long resist the reducing influence of decaying organic matter. As usual under such circumstances,* iron pyrites would be formed, withdrawing in the end all the sulphuric acid from the solution, and forming, instead, equivalent amounts of the respective carbonates. The amounts of the chlorides of sodium and magnesium originally present would thus, also, be relatively increased; and this again tallies with the analytical results. Yet while the proportion between these bases is maintained[*] the actual *replacement* of sulphate of magnesium by the chloride constitutes a change not readily explained. At first sight it would seem that the excess of chlorine belonging to the chlorides of calcium and magnesium must be an outside accession; but our knowledge of the mutual reactions between the substances here present under strong pressure, is perhaps too fragmentary to justify an assertion on this point.

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* See Bischoff, Chemische Geologie, vol. i, p. 559.

The diminution of the potash salts is doubtless referable to their absorption by the clays present, in preference to all other compounds. The filtration of sea-water through soil would, according to Liebig's experiments, produce a like result.

*Conclusions.*—In view of the foregoing facts, the explanation of mudlump phenomena suggested, substantially, by Sir Chas. Lyell, seems the only tenable one; it requires, however, some modification as regards the mass supposed to exert the pressure, and some corollaries as to the mode of action.

I have before suggested, that the rapid protrusion of the mouths of the river into the Gulf, in advance of the body of the delta, is owing to the shelf of "blue clay bottom" extending, at a comparatively slight depth below the sea-level, and with a gentle slope, far out into the Gulf. It is upon this impervious clay that the present bars are based; and upon it, in advance of the bar, will be deposited the finest of the river mud, at a depth at which, perhaps, the sea-water is at the time quite undiluted, and fully adapted to marine life; which will therefore deposit its vestiges in it, associated with the finest particles of driftwood, etc. Mud thus deposited may remain unconsolidated for a great length of time, unless the water be drained off or through it by some means.

The bar, in its annual advance of about 338 feet, will cover over this liquid mud stratum, exerting a pressure much greater than that of the sea; and were it resting on a pervious bottom, the liquid mud would doubtless soon be consolidated into a sheet of clay. As it is, the tendency will be to squeeze it from under the crest of the bar, both seaward and landward. The very gradual seaward slope of the bar will render the movement in that direction a very slow one, under a greater depth of water and heavy frictional resistence. Not so on the land side, where, as the bar advances, the superincumbent pressure is measurably relieved by the erosion of a channel by the

[*] The ratio is for

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|---|---|---|---|
| Atlantic sea-water, | 30·5 : 3·0 | Marindin's Lump water, | 30·5 : 2·8 (min.) |
| German Ocean water, | 30·5 : 4·0 | Southwest Mudlump, | 30·5 : 3·56 (max.) |
| Average sea " | 30·5 : 3·4 | Average of those analyzed, | 30·5 : 3·1 |

current, which, especially in flood time, carries much of the bottom deposit bodily over the bar and drops it to seaward.* At weak points of the bottom inside the bar, therefore, the upward pressure of the mud may cause a bulging up at least to the level of the bar-crest, and, perhaps, taking into account the difference in the specific gravities of the comparatively solid bar and liquid mud, even as far as the surface of the water. But this, considering the question as coming within the domain of liquid statics, would seem to be about the extreme limit to which the bottom itself could be brought up.

I have found the specific gravity of the mud flowing from the West Crater on Marindin's Lump, to be about 1·25; that from the cone on Salt Spring Island, on Northeast Pass, 1·30; while that of bar deposit from the crest of the Northeast bar, wet as brought up by the lead, was 1·75. The heights of communicating columns of these substances, if sensibly liquid, should be as 5 to 7; but this ratio could apply, in the case of upheaval, only so far as the *difference* of level between the bar and the upheaved bottom is concerned, since the latter must be presumed to be similar to the bar in its materials and structure. Should the current, however, continue to denude the crest of the upheaved mass, the rising would continue and the semi-fluid mud might finally break through, forming a mudspring, the height of whose vent above its source might finally increase to the extent corresponding to the difference of specific gravity.

The craters of mudlumps have been sounded to the depth of 24 feet, but no precautions were used to insure reaching the actual maximum depth. In the borings made for the foundation of a lighthouse on the Southwest Pass, by Mr. A. Palms (the record of which was courteously forwarded to me by the Engineer Dept.), a stratum so soft that the augur sank in it by its own weight, was met with at 58 ft., after striking, at 56 ft. a stream of water which "filled the pipe."

If then, the mud stratum, lying, say 60 ft., below the surface, be pressed by a column of deposit of 1·75 sp. gr., mud of sp. gr. 1·25 could thereby be raised 24 feet above the top of the pressing column; and this, considering the average depth of water on the bar, would account for the greatest heights to which cones are built up off the mouths.

But this is a close calculation, even if the data upon which it is based be deemed admissible in the form I have given them; and the frequency and energy with which the upheaving force acts, coupled with the fact that when a mudlump rises in the channel, so far from suffering denudation to the extent required for the breaking through of the mud, it more generally causes a silting up of the channel: seems to me to indicate that a stronger force, less delicately balanced than the equilibrium of the bar, is "at the bottom" of the whole phenomenon.

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* Humphreys and Abbot's Rept., p. 446.

This force, I think, is to be sought in the constantly increasing weight of the alluvial area above the mouths, which, itself possessing a series of mudlump vents at one time, must yet be resting in a great measure upon the still unexhausted mud stratum; as is proven by the existence of active lumps in the marshes, even though the increased resistance of superincumbent deposit as well as matted vegetation must render their occurrence there a rarity. There must still be a communication of liquid pressure between the older and newer portions of the modern delta; and this point is especially strengthened by the fact that a high stage of water in the river, which does not sensibly affect the depth on the bars, yet exerts a decided influence on mudlump activity. The river not only overflows the marshes, but loads them with additional sediment; and doubtless the increased hydrostatic pressure stops many a vent of gas, mud or water, which ordinarily discharges into the river's bed.*

Morgan's Lump, in the marsh of Southwest Pass, and Marindin's Lump on Passe à l'Outre, are now known to have been in undiminished activity for twenty-five years at least. Since that time the bars have moved gulfward a mile and a half; and one would think that, if the activity of the cones depended upon them alone, a notable difference ought to have been observed. But if the main force is a *vis à tergo*, while the bar serves mainly to prevent the escape of the mud to seaward, there is good cause for the secular persistence of vents that have escaped mechanical obstruction.

How far above the present mouths the head of pressure may extend, I do not pretend to conjecture. The borings at New Orleans seem to indicate that the mud stratum originally existed there also, but it would be extravagant to suppose that such pressure as that exerted in the gas wells of that city, could now be felt a hundred miles below. Yet it seems not at all unlikely, that the weight which steadily forces up the liquid mud to the top of Morgan's Lump, seven miles above the mouth, may, in part, be furnished by the enormous mass of vegetation which annually develops in the marshes, willow battures, and perhaps even cypress swamps above. Nor is the effect of gaseous pressure resulting from the constantly progressing decay of organic matter to be overlooked, although I doubt that this cause plays, ordinarily, anything more than a very subordinate part.

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* I give on the plate (page 358) an ideal section, illustrating this explanation of the "origin of mudlumps."

Future observations, systematically carried out, will doubtless solve a good many of the questions here mooted; and though they may not lead to the suggestion of any means whereby the "evil geniuses of the Passes" may at present be conjured, a more precise knowledge of data, as well as of the statics and dynamics of *mud*, may enable us to predict at what point of advance of the mouths into the deeper water of the Gulf, their formation must cease. The Southwest Pass appears to be nearest that consummation devoutly to be wished; and were the closing of the other outlets practicable, the advance of the Southwest bar might become so rapid, as to let the youngest of the living generation witness a diminution of mudlump upheaval. Ultimately, the mouth might thus become similar to those of the Orinoco and Amazon; but until then, ceaseless activity of the river in the formation of bars and mudlumps must, in the interest of navigation and commerce, be met by an equally ceaseless and diligent effort for their removal from the channel. For while a concentration of the river current might possibly be made to maintain the needful depth upon the bars, its utmost erosive energy will be powerless against the tough, inert masses of the mudlumps.

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## ART. LXIII.—*Observations on the Structure and habitat of the Stephanurus dentatus* Diesing, *or Sclerostoma pinguicola* Verrill; by WM. B. FLETCHER, M.D.

THIS parasite, well known throughout the west as the "kidney worm," was first discovered, as I am informed, by Nattser, at Barra De Rio Negro in the white China hog. Although so common and injurious in this country, it had not received attention until 1870, when Prof. Verrill, from imperfect specimens, gave it a name and suggested its importance to the agricultural world.*

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* Subsequent to the publication of my descriptions of this species in the Report of the Connecticut Board of Agriculture for 1870, and this Journal, vol. l, p. 223, I found a notice, apparently of the same worm, by Dr. J. C. White, in the Proceedings of the Boston Society of Natural History, vol. vi, p. 428, Dec., 1858. Dr. White referred it doubtfully to *Stephanurus dentatus* Dies. or *Sclerostomum dentatum* Rud. (an identification that is still quite doubtful) and gave an account of its occurrence in cysts in the leaf-lard of a hog, a male and female together.

Dr. Cobbold, from information received through Dr. Fletcher, has recently published a short account of this parasite, under the same name, in the British Medical Journal (see also Nature, Jan. 26, 1871).

During the past winter I have known of several additional cases in New England. In one instance I obtained a number of fine specimens from a portion of the leaf-lard, taken from a hog raised in Litchfield county, in this state. They occupied large irregular cavities or cysts, sometimes over an inch long and partially filled with dark, disagreeable pus, in which there were numerous eggs. The cysts usually contained a male and female worm, but some contained three and others only one.—A. E. V.

This worm was brought to me in 1866, by a farmer whose hogs were dying of cholera. He had removed the lungs of several, and also cut out fragments of the liver, all of which were spotted over with little cysts containing the worms; in the bronchial tubes down to the minutest branches, they were found in abundance and in situations where no one could have placed them.

With these specimens my conclusion was that they were the *Filaria bronchialis* of Owen, or *Strongylus bronchialis* of Cobbold, and not having at this time made microscopic examination of our well known kidney-worm, the relationship between them did not occur to me at that time.

In November, 1870, while demonstrating the portal circulation in the liver of a pig, full grown, I observed a worm which measured an inch and a half in length, and in all respects resembled the kidney worm, and also reminded me of the worms I had examined five years before. Upon further dissection of the liver I found the worms not only free in the portal veins, but in cysts in various portions of the organ; also some were found in freshly cut holes, directly across the hepatic lobules. The gall-bladder was distended with a dirty, yellowish fluid, the consistency of soft boiled eggs, and although no worms were found, yet the ova were abundant, as they also were in the fluid of the cysts.

Being convinced that the worm formerly examined in the lungs was the same as the worm now found in this new locality, and finding it oviparous, I gave up my opinion as to its being a *Filaria bronchialis*.

From the date of this discovery, I frequented the slaughter houses and pork-packing establishments, and found the worm in most instances in the pelvis of the kidney, or in cysts in the fat around them. Four times I have found the worm in the bronchial tubes, twice in the hepatic vein and in the right side of the heart; also in cysts throughout the fatty parts of the animal.

Frequently, when no worms were discovered, the eggs were abundant in the thick mucous-looking fluid in the pelvis of the kidney. This fluid contained, besides eggs, desquamated renal tubules, or casts and oily granules.

In no instance have I found worms in an immature state, which shows that the eggs, in all probability, go through some other beast before they enter the swine, to become sexually mature.*

The symptoms in hogs, which are referred to the "kidney worm," are due to a paralysis of motion in the hind legs; the hog drags the hind quarters along the ground from place to place in search of his food, although it is by no means proven that the worm is the real cause, unless we be able to demonstrate its existence in some cerebro-spinal center, or some point more likely to destroy the reflex power in the cord itself.

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* It is quite as probable that they may hatch in water, and thus enter the hog's stomach with its drink.—V.

*Structure.*—The head and oral cavity are alike in male and female. The oral cavity is rather oval than round, and is surrounded by a hexagonal frame, each corner having a papilla and hooklet, while each side is armed with six serrate teeth.

Looking into the oral cavity, it is funnel-shaped, having three openings at the back, one of which connects directly with the œsophagus, while the others appear to connect with the water vessels.

The intestine is long and contains some pigment granules, arranged in dendritic forms, throughout its length; the whole is thrown into convolutions, and gives an almost black appearance to the worm, except when the white oviducts distended with eggs, or the seminial vessels of the male are folded over the intestine, when it has a white, mottled appearance.

The caudal extremity of the female is spindle-shaped, but has two little bursæ higher up. In the male it is formed by three-lobed bursæ, above which are two well developed flexible spiula.

## ART. LXIV.—*On certain Forms of the Electrical Discharge in Air;* by Prof. ARTHUR W. WRIGHT, Williams College.

IN a paper published in this Journal, May, 1870, the writer described a peculiar form of discharge between the poles of the Holtz electrical machine, worked at high tension, and without condensers. A non-luminous discharge was observed to take place over a considerable interval, with the production of a jet or brush upon the negative, and a glow upon the positive ball, and the formation in this glow of shadow-like images of objects placed between the poles. It was shown also that the discharge passed over lines having a definite form, and that they were curved so as to form arcs issuing normally from the surfaces of the poles.*

When the condensers are employed the dark discharge also occurs under certain circumstances, and exercises an important influence on the nature of the phenomena observed. If the poles of the machine are gradually separated, a point is soon reached, at which the bright sparks appear very irregularly or cease altogether, the polar interval being then usually some four or five inches, but varying considerably with the circumstances of the experiment. Examination readily shows that at such times a dark discharge is taking place, and shadows may be produced in the same manner as when the condensers are not used, but less readily, and with less distinctness. The discharge now becomes very variable in character, passing from the ordinary bright spark to the non-luminous form already described, and all intermediate grades may be observed, according to the energy of the jet, or the tension of the poles.

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* Faraday described the form of discharge which produces the glow, and called it the *dark discharge.* He also held that the inductive action between two bodies took place along curved lines, as was indicated by certain forms of the luminous discharge. (Exper. Res., 1444; 1544, et seq.; 1215, et seq.). The occurrence of the shadows, however, enables us to trace these lines of action very accurately, especially when the glow is made to take the form of a narrow ring, as is described in the paper referred to above.

Often an incomplete spark passes, consisting of two portions issuing simultaneously from the poles, the middle portion being quite dark. The two ends, in this case, are usually characterized by many branches, which are more numerous and longer in the part next the positive pole, and the whole exhibits a reddish color, and a feeble degree of illuminating power, as compared with the perfect spark, while the detonation of the discharge is correspondingly enfeebled. This is the case distinguished by Riess as the "weak spark" (*schwache Funke*),* and it is characterized by him as a distinct form of the discharge, due to a diminution of the tension of the electricity.

That under particular circumstances, or with a special arrangement of the machine, such as to give electricity of lower tension, the weak sparks are produced more frequently, is true, but the fact that they are often formed when the potential of the machine is very high, shows that they are not dependent on that alone, but rather upon the tension at the poles, at the instant of discharge. In these cases, the poles being separated but a few inches, a rapid jet-discharge takes place, with the production of the phosphorescent glow above described. Now when this occurs, a silent discharge is going on through the air, and this may be so energetic as completely to prevent the formation of the ordinary spark, and to lower the tension at the poles very considerably. A variation in the rapidity with which the machine is worked, or the prevention or weakening of the jet by any means, may then raise the tension of the poles sufficiently to determine the passage of the weak sparks, or even of the ordinary bright ones.

It may be supposed that, at the distance in question, the mutual inductive influence of the two poles is just sufficient to cause a local increase of tension there, to such a degree as to enable the negative electricity to overcome the resistance of the air, thus setting up a sort of current between the poles. And it is noticeable that after such a current is once established the poles may often be gradually separated to a much greater distance without interrupting it, though if, after this greater separation, the spark passes, or the poles are touched with a conductor, the current is not readily re-established without approaching them to each other again. The analogy of this circumstance, as well as of the curved form of the lines which the current often exhibits, with similar phenomena of the voltaic arc, is obvious.

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* Pogg. Ann., Bd. cxxxvii, p. 451; Bd. cxxxix, p. 508.

Riess has remarked (loc. cit.) that the weak spark may be regarded as the germ of the complete and bright sparks. We may go further, however, and say that the brush-discharge is the germ of both the others, and indeed of most of the luminous forms of discharge. When an elongated conductor, connected with the machine and highly charged, is insulated, and so far removed from any other conducting body that the attractive influence of the latter is null, or may regarded as such, the tension quickly rises to a maximum at the extremities, and, if these terminate in blunt points or small balls, finally overcomes the atmospheric resistance, and a discharge occurs in the form of a brush, or rather in that of a tree, the stem of which is toward the charged body. The ramified form of the discharge is evidently due both to the tension of the electricity, and to the small electrical capacity of the air. The portion of the air in contact with the pole becomes highly charged and is then repelled, and a stream of such particles will follow in rapid succession. Each of these particles communicates a portion of its charge to others which it touches, and so is in a condition to receive more electricity from the charged body. Thus is established, not merely a convective action in the particles of air, but also a current of electricity passing along the stream of particles. The stream or thread of air is heated by the passage of the electricity, and all the more as its resistance is very great. With the rise in the temperature, however, its conducting power is increased, and it thus not only conveys a larger quantity of electricity, but becomes more highly charged, until finally, acting itself as a highly charged body, it gives rise to other streams forming branches or lateral discharges, which in turn give rise to other ramifications, thus producing the familiar arborescent forms of the discharge.

When two conductors oppositely charged with electricity are brought so near one another that inductive action becomes sufficiently intense, we may have either the silent and non-luminous discharge, or if the quantity of electrity is too great to find its equilibrium in this manner, the brush-discharge taking place from both poles simultaneously, and greatly intensified by their mutual action. The branches become longer, more distinct, and more highly luminous, and when the distance between the poles is so small that the branches are separated by a comparatively small interval, we may have the weak spark. Finally, when the quantity of the electricity is increased, or the tension at the poles becomes greater, or the distance between them is lessened, the branches of the primary discharge may become so much extended as to meet, or at least to come into close proximity. Now it is well known that when a body has been traversed by or charged with electricity either positive or negative, it becomes a better conductor for electricity of the opposite nature. In case then any branch from one side, say the positive, should meet one from the other side, namely, the negative, each would form for the electricity of the other a better path than the surrounding air, both from this cause, and from the fact that it has a higher temperature. The main body of the charge then would follow the path thus opened, and the thread of air which it traverses being thereby very highly heated would exhibit the intense brightness of the ordinary spark. The fact that the discharge passes along the irregular branches of the brush then sufficiently explains the crinkled and variously contorted forms of the bright spark, when the tension is very great. With a machine affording electricity of high tension, the branches accompanying the bright sparks, when the latter have a length of some inches, may be readily seen even in the daylight. The longer and more numerous proceed from toward the positive side, but those directed from the negative are frequently visible. They are much shorter and less distinct than the former. Sometimes short and faint branches issue from different points of the negative pole itself, several appearing at once, simultaneously with the spark.

From the fact that the air in the path of the spark is rendered a better conductor by the intense heat, it might be expected that where a rapid succession of discharges passes, the successive sparks would follow the same path, and therefore have the same form, as the air-thread would not instantly communicate its heat to the air surrounding it. The researches of Feddersen and of Prof. Rood have shown that in the discharge of the Leyden jar through a short interval, the spark is intermittent in its character, consisting in fact of several discharges in rapid succession. As the bright path appears to the eye single and sharply defined, it is very probable that their paths are all identical, namely that of the first act of the discharge. With the Holtz machine also, used without condensers, the discharges may be made so rapid when the poles are but an inch or less apart, as to appear continuous, and to give a tone whose pitch can be definitely recognized. In such a case the lines of the discharge seem to oscillate rapidly in a plane which has different inclinations as the thread of air is moved in one direction or another, either by currents in the surrounding air, or, as apparently happens, by the attraction of the charged parts of the machine. When no disturbing cause affects it, the plane will tend to take a vertical position, from the diminished density of the air-thread which is heated by the discharge. In any case, as it moves from its first position, and the repeated discharges pass through it, it occupies positions successively farther from the original line, until from its increased length the resistance becomes too great, and the discharge occurs again near the initial position, and so on. Owing to the persistance of the impression in the eye several lines are seen at once, apparently simultaneous, but that they are not so may be readily made evident by suddenly moving the eye while looking at them, or by viewing them in a mirror which is quickly turned about, when the intervals between them are seen to be drawn out and enlarged, whereas these would be unchanged if the discharges occurred at the same instant, or were continuous.

The effect becomes much more striking when the poles are so shaped as to increase the vertical length of the space between them. For this purpose an experiment was made by attaching to the inner extremity of each electrode a brass tube about six inches in length and half an inch in diameter, the upper end being hemispherical, and the tubes fixed in a vertical position. When the electrodes were pushed in so that the tubes were from one-quarter to one-half of an inch apart, and the latter were brought as nearly as possible to parallelism, sparks passed in quick succession between them, and now and then appeared to rise rapidly from the lower portion of the interval toward the top. When the condensers were employed, and the tubes were brought nearer together, the same effect was observed, but indistinctly and less frequently, as the discharges succeeded one another too slowly to make it readily apparent.

A phenomenon of the same kind is often presented in lightning flashes. It is no uncommon thing during a violent thunder-storm, to see two, three, or even more discharges of lightning follow the same path in quick succession, the interval between them being but the fraction of a second, yet sufficient to be distinctly perceptible. In this case the mass of air heated by the discharge is comparatively great, so that a considerable time is required for it to become cooled by the enveloping air, and it therefore retains its superior conductivity long enough to determine a repetition of the discharge through it.

The formation of the electrical shadow discussed in my former paper, as has been suggested by Mr. C. F. Varley,* who has more recently obtained results similar to those there described, appears to afford a satisfactory explanation of a singular and very interesting phenomenon which has occasionally been observed in the case of objects struck by lightning, especially of persons killed by it. A number of instances are on record where the person struck was found to have impressed upon some portion of the body a delineation of some thing near him at the time of the stroke, and a similar effect has been noticed also in the case of inanimate objects. Dr. Franklin mentions an instance in which an exact representation of a tree was imprinted upon the breast of a man who was standing near it when struck by lightning. A number of similar and very remarkable cases are cited in a paper presented to the Royal Society of England, by Mr. Andrés Poey, director of the observatory at Havana.*

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* *Nature*, vol. iii, p. 238, in report of Proc. Roy. Soc. for Jan. 12, 1871.

Mr. Varley also mentions cases reported by sea-captains, of images of certain brass numbers attached to the rigging of a ship being printed by the lightning upon the body of persons killed by it, and supposes the brass numbers to have acted as a negative pole in respect to the person struck. But it is unnecessary to suppose that the discharge in such cases always proceeds from the object delineated, and many of the instances recorded forbid such a supposition. The experiments in the production of the electrical shadows show that it is merely necessary that the object should interrupt the lines of action of the electricity, and that it may be at a considerable distance from the electrified cloud, the chief and indispensable condition being that the latter should be negatively electrified. We should then have the body exposed to the lightning positively electrified by induction, and, as the tension became sufficient, the dark discharge accompanied by the glow would take place, followed by the lightning-stroke. If then any object should be in the path of the discharge, its image would be formed in the glow, and this might, in rare cases like those recorded, be sufficiently intense to leave a permanently visible impression. The fact that the image in many cases is very much reduced in size, shows indeed that the cloud, or other body serving as the negative pole, is much more distant from the object represented than is the body struck, for in the experiments described in my former paper, it was found that the image of the paper grating grew much smaller as it approached the positive pole, and this effect would be likely to be still more marked where the negative body had a very extended surface, as would be the case were it a cloud.

In some experiments recently made, the negative pole of the machine was covered with several folds of woolen flannel which prevented the formation of a jet. Instead of this, several square inches of the cloth were covered with a bright glow, somewhat resembling that on the positive ball, but, unlike that, seemingly made up of innumerable minute points or patches of light, having a peculiar swarming motion, like that described by Neef in his researches upon the negative discharge as seen under the microscope. When the paper grating was placed between the poles, the image on the positive was not readily obtained with distinctness, but was generally much smaller than when the negative pole was not thus covered.

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* See an abstract of this paper in the Ann. Sci. Discovery, 1858, p. 226.

A similar effect, but much more brilliant, was produced when, the poles being separated nine or ten inches, the hand was placed upon the negative, and the arm was approached to the positive pole. The woolen sleeve exhibited a bright glow covering a large area, and appearing like a strongly phosphorescent powder sifted profusely upon it. When this was approached so near that the interval was only an inch and one half or an inch, the positive glow became much more intense, and took a delicate purplish tinge, and the whole space between the two was filled with a very faint auroral light, which appeared, unlike other forms of the discharge, to be perfectly continuous and steady. The dark discharge under these circumstances was evidently so much intensified as to become luminous and visible.

Williamstown, Mass., April 22, 1871.

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## ART. LXV.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XIV.—*Descriptions of new and imperfectly known Ascidians from New England;* by A. E. VERRILL.

[Continued from page 294.]

### Family, DIDEMNIDÆ.

In this family we include, together with the typical genera, *Leptoclinum* and its allies, which have been separated as a distinct family (*Leptoclinidæ*) by Prof. Gill.* There appears to be no definite ground for such a distinction. The genera *Didemnum* and *Leptoclinum* are very closely allied, and scarcely distinguishable so far as the structure of the individual zoöids is concerned, the difference being chiefly in the mode of aggregation. Such differences are generally of too little importance among compound animals to form the basis of family distinctions, unless accompanied by important differences in the individuals themselves.

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* Arrangement of the Families of Mollusks, p. 23, 1871.

### *Lissoclinum*, gen. nov.

Allied to *Leptoclinum.* The colonies form more or less broad, thin, encrusting masses or sheets, soft and somewhat gelatinous in texture, without calcareous corpuscles. The zoöids are arranged in more or less irregular, scattered systems, consisting of many individuals placed along cloacal ducts, which are connected with common external orifices. Branchial region, or "thorax," equal to or larger than the abdominal. Branchial orifice with six papillæ. Anal orifice lateral or subterminal, prominent. Abdomen separated from thorax by a short peduncle. Stomach with longitudinal glandular ridges. Ovary sublateral, when filled with eggs projecting backward beyond the abdominal viscera. Eggs large.

This genus differs from *Didemum** and *Eucœlium* in having common cloacal ducts and orifices, as well as in the form and position of the abdomen and ovary. From *Leptoclinum* it differs in the soft gelatinous texture and in the form and structure of the zoöids.

Besides the two following species, this genus appears to include *L. gelatinosum* and *L. Listerianum*, both of which were referred to *Leptoclinum* by Milne Edwards.

### *Lissoclinum aureum*, sp. nov. Figure 26.

Colonies encrusting, forming nearly flat masses, about ·15 to ·20 of an inch thick, and up to an inch or more in diameter. Texture soft and gelatinous, semi-transparent. Systems irregular, consisting of many individuals arranged along the elongated, common cloacal ducts. Branchial orifice with six rather elongated and slender papillæ. Branchial sac broad and laterally extended, with the transverse vessels quite distinct, and the longitudinal ones less so. The œsophagus is short; stomach more or less oval and elongated, with well-marked longitudinal ridges or glands; intestine large, prolonged toward the anal orifice. The anal tube is nearly terminal, conical, and more or less prominent. Ovary lateral, when full of eggs projecting backward beyond the end of the abdomen. Color of the common mass light yellow; zoöids bright orange.

26

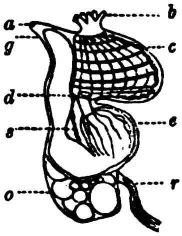

Figure 26, *Lissoclinum aureum* V.—One of the zoöids, enlarged 10 diameters; *a*, anal orifice; *b*, branchial orifice; *c*, branchial sac; *d*, œsophagus; *e*, stomach; *g*, end of intestine; *o*, ovary distended with eggs of various sizes; *r*, "marginal tube" or pedicle of a bud; *s*, spermatic duct. (From a camera-lucida drawing by the author).

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* The genus, *Didemum*, as established by Savigny and adopted by Milne Edwards, includes two distinct groups: the first having calcareous corpuscles in its integument; the second soft and gelatinous throughout. The latter may be called *Lioclinum.* It includes *L. viscosum* (Sav.) and *L. gelatinosum* (Edw.).

The zoöids, as preserved in glycerine, are ·10 to ·13 of an inch long; breadth, across branchial sac, ·05 to ·07; across abdomen, ·05 to ·06; length of thorax ·04 to ·07; of peduncle ·005 to ·010; of abdomen ·045 to ·055.

Eastport Harbor, 12 to 20 fathoms,—Expedition of 1870.

The cloacal ducts of a specimen taken in August, were found to be filled with chains of eggs containing the tadpole-shaped embryos in an advanced stage of development. No eggs or embryos were observed in the atrium of the numerous zoöids examined.

### *Lissoclinum tenerum*, sp. nov.

Colonies encrusting shells, ascidians, etc., forming thin, soft, gelatinous crusts, which are translucent, and filled with numerous, very small zoöids, which are nearly uniformly distributed. Cloacal openings small, round, numerously scattered over the surface. Zoöids have the branchial region more elongated and narrower than in the preceding species, with a somewhat larger peduncle between it and the abdomen, and with the latter, exclusive of the distended ovaries, smaller than the branchial region. Stomach elongated, longitudinally ribbed. Branchial tube elongated, with six short papillæ; anal short, broad, lateral, below the middle of the branchial sac, slightly six-lobed.

Color not observed in life; in alcohol transparent whitish, with yellowish white zoöids.

The colonies are up to two inches in diameter and ·10 to ·12 thick; zoöids about ·07 long; the thorax ·032, by ·02 wide; the abdomen ·025 long, by ·015 in diameter, exclusive of the distended ovaries, which in some cases are as large as the entire body.

Eastport, Me., 10 to 40 fathoms, shelly bottom,—Exp. 1870; Banks of Newfoundland,—T. M. Coffin.

This species may be easily distinguished from the preceding by the very small zoöids and paler color. The zoöids are very different in form, owing to the lateral position of the anal orifice. The stomach is remarkably elongated and slender in young individuals, projecting into a posterior prolongation of the abdomen. The eggs are few and relatively very large. Many of them appear to become detached by rupturing the membranes of the ovary, and escaping into the gelatinous common tissue, develop there.

The development of such eggs* is *direct, without passing through a tadpole-shaped larval state.* Scattered through the common gelatinous mass, young ones may be found in all stages of development. The branchial and anal tubes are widely separated in the young, and the stomach projects backward beyond the body.

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* With the alcoholic specimens it is not possible to trace completely the early stages of this development, or to be perfectly certain that these egg-like bodies are genuine eggs, although some of them appear to contain, at first, a germinal vesicle.

### *Leptoclinum albidum*, sp. nov.

Colonies encrusting stones, dead shells, ascidians, etc., forming broad, thin, irregular, coriaceous crusts, with an uneven surface, filled with minute, white, spherical, calcareous grains or corpuscles, which, under the microscope, have the surface covered with projecting points. Surface of the crusts covered with small, irregular, scattered prominences, in which the branchial orifices are situated. Cloacal orifices few and distantly scattered. Systems irregular, the zoöids scattered, but often arranged in rather indistinct concentric circles around the cloacal openings.

Color white, the zoöids light yellowish.

The colonies often become 1 to 2 inches across, sometimes 2 inches or more long, and only ·25 or less wide; thickness seldom more than ·10, commonly about ·05; zoöids ·02 to ·03 long; diameter ·01 to ·012 of an inch.

Eastport, Me., low water on under side of rocks, to 100 fathoms on stony and shelly bottoms, common.—Expeditions of 1863, '64, '68, '70; Grand Menan, 10 to 15 fathoms,—Exp. 1870; Labrador,—A. S. Packard; Mingan Islands, Lab.—A. E. Verrill; Banks of Newfoundland, — T. M. Coffin; Thimble Islands (near New Haven), Conn., 6 fathoms, on rocky bottom,—A. E. Verrill.

### *Leptoclinum luteolum*, sp. nov.

This species forms thin, coriaceous crusts, like the preceding, and filled in the same way with similar spherical corpuscles. The branchial orifices open at the summits of low verrucæ. The cloacal orifices are small, with four to six lobes, and distantly scattered. Color deep salmon, or somewhat rosy.

The crusts are of all sizes up to 2 inches or more in diameter, and are usually somewhat thicker than in the preceding species, with larger and darker colored zoöids.

Eastport, Me., and Grand Menan, with the preceding species,—Expeditions of 1861, '63, '64, '68, '70,

Under the name of "*Didemnium roseum* Sars" Dr. Packard* probably included both this and the preceding species. Mr. Binney, in the second edition of Gould's Invert. of Mass., has merely copied from Dr. Packard's work.

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* Memoirs of the Boston Society of Natural History, vol. i, p. 276, 1867.

## ART. LXVI.—*Notice of some new Fossil Reptiles from the Cretaceous and Tertiary Formations;* by O. C. MARSH, Professor of Paleontology in Yale College.

THE remains briefly described in the present preliminary notice were collected by the Yale College party during their explorations last summer in the Rocky Mountain region. The specimens from the Cretaceous formation are of great interest, as they further illustrate the remarkable development in this country, both in numbers and distinct forms, of the Mosasauroid Reptiles, which appear to have been comparatively rare in other parts of the world. Fortunately, moreover, some of these remains serve to clear up several obscure points in the structure of these reptiles, and prove conclusively that they had a well developed pelvic arch and posterior limbs; although up to the present time no satisfactory indication of this had been discovered, and the eminent paleontologists who have recently made these animals an especial study consider them probably destitute of these extremities. The remains found in the Tertiary deposits are also of importance, since they show that types of reptilian life, almost unknown hitherto from that formation in the West, were, in one of the ancient lake-basins at least, abundantly represented there during that period.

### CRETACEOUS REPTILES.

### *Edestosaurus*[*] *dispar*, gen. et sp. nov.

This genus, which so far as now known includes but two species of small Mosasauroids, is especially distinguished from *Clidastes*, its nearest ally, by the insertion of the pterygoid teeth, which are pleurodont in the anterior half of the series, and in the posterior portion have the outer dental margin protected by a low parapet of bone. From *Platecarpus*, the genus is widely separated by the zygosphene articulation of the vertebræ. The pelvic arch and posterior limbs were well developed, but there was apparently no sacrum.

The present species is mainly established on the more important parts of a skeleton, including the greater portion of the skull, both quadrates, about seventy vertebræ, parts of the scapular and pelvic arches, and fragments of the limbs. The remains are in an excellent state of preservation, and indicate a Mosasauroid reptile, apparently about thirty feet in length, or near the size of *Clidastes iguanavus* Cope.

The vertebræ possess the complete zygosphene articulation. In the cervicals and anterior dorsals, the cup and ball are somewhat inclined; in the posterior dorsals and lumbars, less so;

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[*] Εδεστὴς, devourer, and Σαῦρος, lizard.

and in the anterior caudals they are nearly, but not quite, vertical. The articular faces in the cervicals are a broad transverse oval, faintly emarginated above for the neural canal. In the dorsals and lumbars the cup continues transverse, and the emargination is deeper, but in the anterior caudals the outline becomes a vertical oval. The posterior lumbars have the faces hexagonal, with both the upper and lower borders excavated, the latter due to the concave inferior surface of the centrum in this part of the series. The rim of the articular ball in all the vertebræ preserved is surrounded by a distinct, but not deep, double groove. The chevron bones are coössified with the centrum.

The quadrate has the same general form as in *Clidastes propython*, but the external angle is situated further back, and has a notch in its posterior margin directly above the meatal pit. The postero-superior process is shorter, with a compressed free end. The teeth are curved, and somewhat compressed. The enamel is smooth, and shows faint indications of broad facets on the basal half. There appear to have been thirteen mandibular teeth, with alveolæ for two more. The splenial extends forward to the base of the seventh tooth from the front. The pterygoid bones were separated, except perhaps at their anterior inner margin. There were at least fifteen pterygoid teeth. The crowns are smooth, with distinct posterior cutting edges.

There is a remarkable difference in size between the cervical vertebræ and those of the lumbar region, where the centra reach their maximum. Although the series is here apparently complete, there are no indications of a sacrum. The discovery of the nearly entire pelvic arch with these vertebræ, and the preservation, also, of the corresponding anterior arch, throws much new light on the nature of the limbs in this group of reptiles. These specimens clearly indicate that the bones forming this portion of the skeleton in the Mosasauroids have not unfrequently been incorrectly assigned, and that two at least of the allied genera, viz: *Clidastes* and *Liodon*, also possessed effective posterior limbs. Several series of specimens illustrating this are in the Museum of Yale College, and will soon be described by the writer.

In this species the scapula and coracoid bones are similar to those of *Mosasaurus*. Both are short and flat; each thickened at one extremity, which it contributes to form the glenoid cavity, and at the other, thin and expanded. The coracoid is perforated by a foramen not far from its anterior margin. The pelvic arch resembles that of *Ichthyosaurus*, and, as in that genus, is considerably smaller than the anterior arch. The acetabulum is cup-shaped, and is not unlike that in *Trionyx*. It is formed by the union of the ilium, pubis, and ischium, the first furnishing the largest, and the last the smallest portion of the articular surface. The body of the ilium is remarkably slender, and the proximal end was probably attached to a vertebra merely by cartilage. The distal extremity is much expanded, subrhombic in outline, and has three nearly equal facets on its articular surface, that forming part of the acetabulum being the largest. The adjoining proximal end of the pubis is more compressed than that of the ilium, and has three corresponding articular facets, the acetabular being nearly flat, and the others concave. The portion below is flattened, and has a foramen near its anterior margin. The proximal end of the ischium is also trihedral, and somewhat smaller than that of the pubis. The articular surfaces of all these bones were thickly capped with cartilage. The few phalanges found with these remains are rod-like, depressed, and much constricted medially. The ends are transverse, and have been covered with cartilage. They indicate that the limbs were paddles, not unlike those of *Plesiosaurus*, but more slender.

*Measurements.*

| | | |
|---|---|---|
| Length of axis, | 26· | lines. |
| Length of axis, with odontoid process, | 32· | “ |
| Width between diapophyses, | 26·8 | “ |
| Width of articular ball, | 11·25 | “ |
| Depth of articular ball, | 9·25 | “ |
| Length from edge of cup to end of ball in eleventh vertebra, | 25· | “ |
| Width of ball, | 14· | “ |
| Depth of ball, | 12· | “ |
| Length of first caudal on inferior surface, | 16· | “ |
| Width of articular cup, | 14·5 | “ |
| Depth of cup, | 15· | “ |
| Length of quadrate, | 30·75 | “ |
| Transverse extent of distal end, | 18·75 | “ |
| Length of pterygoid bearing the five anterior teeth, | 33·5 | “ |
| Length of portion with the five posterior teeth, | 23· | “ |
| Antero-posterior diameter of distal end of ilium, | 14·5 | “ |
| Transverse diameter, | 11·30 | “ |
| Diameter of shaft, | 4·75 | “ |
| Greatest diameter of proximal end of pubis, | 16·30 | “ |
| Transverse diameter, | 10· | “ |
| Greatest diameter of proximal end of ischium, | 14· | “ |
| Transverse diameter, | 9· | “ |

This species is readily distinguished from *Clidastes iguanavus*, by the less depressed and more constricted centrum in the anterior dorsals. It differs essentially also from *Clidastes cineriarum* Cope, in having transverse articular faces in the vertebræ of the dorsal and lumbar region. The specimens representing this species were discovered, in November last, by Mr. H. B. Sargent and the writer, in the gray Cretaceous shale, on the North Fork of the Smoky River, in Kansas.

### *Edestosaurus velox*, sp. nov.

This species was about two thirds the size of the preceding one, and very nearly allied to it. It is represented at present by a number of specimens found together, including the greater part of the skull, with the quadrates, and several vertebræ, which, however, are too much crushed to give reliable measurements. Another series of specimens, consisting mainly of anterior dorsal vertebræ, well preserved, was found near the same locality and appears specifically identical. They are therefore included in the description of the species, and furnish the vertebral characters of the dorsal region, where the first series is deficient.

The muzzle in this species is obtusely pointed. The premaxillary is narrow and simple, and unites with the maxillaries, anteriorly at least, by suture, differing in this respect from the known species of *Clidastes*. There are four premaxillary teeth, smooth and subcompressed, like those of the maxillaries. The pterygoid bones are very similar to those of the preceding species. The quadrate, also, has the same general form, but presents several marked differences. The great ala is less curved vertically, and is concave transversely on both surfaces. The alar process has its articular surface very narrow in its extension over the great ala, while in *E. dispar*, it is broad and abruptly terminated. There is no notch in the posterior margin of the external angle. On the ridge below this angle, and nearly opposite the meatal pit, there is a prominent rugosity, which is rudimentary or wanting in the larger species. In the latter, moreover, the posterior margin of the hook is reflected for some distance, producing a broad articular face. In the present species, this surface is only represented by a narrow tongue, projecting toward the meatal pit.

In the cervical and dorsal vertebræ, the articular faces are transverse, and in the latter, distinctly cordate, the superior emargination being deeper than in the preceding species. In the anterior dorsal region, the vertebræ have a more transverse cup and ball, which are also apparently more inclined from a vertical.

*Measurements.*

| | | |
|---|---|---|
| Length of anterior dorsal vertebra, from edge of cup to end of ball, | 22· | lines. |
| Width of ball, | 12· | “ |
| Depth of ball, | 10· | “ |
| Length of pterygoid bearing five anterior teeth, | 25·5 | “ |
| Length of pterygoid with five posterior teeth, | 19· | “ |
| Length of quadrate, | 27·75 | “ |
| Transverse diameter of lower end, | 14· | “ |

This species was apparently about the size of *Clidastes intermedius* Leidy, but may easily be distinguished from it by its smooth teeth, and the more nearly vertical articular faces of the vertebræ. The present specimens were found by the writer, in the gray shale, near the North Fork of the Smoky River, in Western Kansas.

### *Clidastes Wymani*, sp. nov.

The remains on which this species is based consist of a series of cervical and anterior dorsal vertebræ, with portions of the skull and quadrates of the same individual, and portions of another skeleton, including a nearly or quite complete vertebral series from the posterior lumbars to the extremity of the tail. The two suites of specimens correspond so closely in size and proportions, as well as in special characters, that they may with comparative safety be referred to the same species.

The specimens indicate a small reptile, very near *Clidastes propython* in size, but differing from that species in several important particulars. One of the most noticeable of these is the form of the muzzle, which in the present example has a short and obtuse extremity, not unlike that of *Liodon proriger* Cope. The basioccipital has the condyle deep vertically, and only a shallow groove on its upper surface for the neural canal. The quadrate has the postero-superior process free at its lower extremity. Just below this, there is a prominent rugose knob, with a deep pit under it, entering from the external border.

In the cervical vertebræ, the outline of the articular faces is transverse cordate, the ball of the axis showing a marked difference in this respect from that of *Clidastes propython*, where it is subpentagonal. The centra of the anterior dorsals are elongate, and much constricted behind the diapophyses. The cup here becomes broader, and the emargination deeper. In the anterior caudals, the articular faces are a broad vertical oval. The vertebræ in this region have deeply concave sides. In the twenty-fifth caudal, or vertebra with chevrons where the last rudiment of the diapophysis has disappeared, the transverse and vertical diameter of the cup, and the length of the centrum are very nearly equal. In the median caudals, the centra become compressed, the cup is very shallow, and the neural spines and chevrons are directed backward. The posterior caudals are much compressed, with the cup very deep, the neural spine still inclined, but the chevrons are nearly perpendicular. The entire caudal series, excepting those at the very extremity, have coössified chevron bones. There are eighty-one caudal vertebræ preserved, the last fifty being continuous. The terminal ones are less than one-twelfth of an inch in transverse diameter! This series would imply that there were considerably more than two hundred vetebræ in the entire column, and hence indicates for these reptiles a much more attenuated, serpent-like form than has hitherto been supposed. The present species was probably about eighteen feet in length.

*Measurements.*

| | | |
|---|---|---|
| Length of axis, with odontoid process, | 19· | lines. |
| Width between diapophyses, | 17· | " |
| Width of ball, | 8· | " |
| Depth of ball, | 7· | " |
| Depth of centrum, with attached hypapophysis, | 10·3 | " |
| Length of sixth cervical, without ball, | 13· | " |
| Length of neural arch, | 10· | " |
| Width in narrowest point, | 6·40 | " |
| Width of cup, | 9· | " |
| Distance from end of muzzle to center of first tooth, | 5·5 | " |
| Length of caudal on which diapophyses first disappear, | 9·1 | " |
| Width of cup, | 9· | " |
| Depth of cup, | 8· | " |
| Length of caudal, apparently next to last, | 1·40 | " |
| Transverse diameter of same, | ·95 | " |

This species is named in honor of Professor Jeffries Wyman, of Harvard University. The remains at present representing it are from the gray Cretaceous shale of Western Kansas. The first series of specimens here described was discovered by Mr. H. B. Sargent, on the North Fork of the Smoky River. The caudal series was found by the writer, about ten miles further east, near the Smoky River.

### *Clidastes pumilus*, sp. nov.

The smallest Mosasauroid reptile at present known is indicated by the anterior portion of a skeleton, which appears to be specifically distinct from any hitherto described, although seemingly most nearly related to the species characterized in the preceding description. Aside from the more diminutive size, however, there are several noticeable differences. In the present species, the inner third of the distal articular surface of the quadrate is much broader, and less separated by constriction from the main condylar surface. The cotylus of the articular bone, also, has a corresponding greater width. The rugose knob near the distal end of the quadrate is similar to that in the last species, but has no pit beneath it. The hook is comparatively short, and has a free compressed extremity. Its articular margin is not deflected toward the meatus. The basioccipital is longer, deeply excavated for the neural canal, and its condyle is much less elevated. The teeth are nearly round at the base, somewhat curved, and with smooth enamel. The articular faces of the cervical vertebræ are nearly vertical, and have a broad transverse oval outline, with a faint superior emargination. The free hypapophyses preserved are short, and triangular transversely.

*Measurements.*

| | | |
|---|---|---|
| Length of axis, without odontoid process, | 12·3 | lines. |
| Width of ball, | 7·10 | " |
| Depth of ball, | 5·75 | " |
| Transverse extent of distal end of quadrate, | 10· | " |
| Length of basioccipital, | 13·45 | " |

This species was probably about twelve feet in length. The specimens representing it, so far as now known, were found by Mr. H. B. Sargent, of the Yale College party, in the yellow Cretaceous limestone, on the south side of the Smoky River, Western Kansas.

## TERTIARY REPTILES.

### *Crocodilus ziphodon*, sp. nov.

Some of the most interesting remains of fossil reptiles discovered by the Yale party, during their explorations last summer in the Tertiary beds of the Green River basin, west of the Rocky Mountains, were those of Crocodilians, several of which prove on examination to be new to science. One of these, a small animal to which the present name may be applied, presents characters which separate it at once from any known Crocodilian, living or extinct. Perhaps the most marked feature is seen in the teeth, which resemble those of some of the Dinosaurs. The crowns are much compressed, and somewhat curved, especially in those apparently pertaining to the front part of the series. The sides are smooth, the edges very sharp, and marked with fine serrations from the base to the apex. The skull was rugose, and in places deeply pitted. The quadrate, to judge from a single detached specimen found with one series of the remains, and probably belonging to them, is quite stout, with the lower surface smooth, and the distal end subtriangular in outline. The back of this reptile was covered with thick scutes, closely united by suture, and marked with numerous deep pits.

*Measurements.*

| | | |
|---|---|---|
| Length of crown of tooth, | 8· | lines. |
| Transverse diameter at base, | 2·60 | " |
| Antero-posterior diameter at base, | 4·75 | " |
| Transverse diameter of distal end of quadrate, | 15·80 | " |
| Vertical diameter, on median line, | 7·90 | " |

The specimens here described were found by Mr. H. B. Sargent, Mr. J. R. Nicholson, and the writer, at the Grizzly Buttes, near Fort Bridger, Wyoming. The geological horizon is upper Eocene, or perhaps Miocene.[*]

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[*] This Journal, vol. i, March, 1871, p. 192, and May, 1871, p. 322.

### *Crocodilus liodon*, sp. nov.

A second small species of Crocodile is indicated by the more important parts of a skeleton from the same Tertiary deposits as the preceding species. In this specimen the teeth are smooth, nearly round at the base, slender, with compressed points. The cutting edges are prominent and sharp, but not serrated. The jaws are quite slender. The quadrate is short, concave on its upper surface, and very flat at its distal end. The usual pneumatic foramen on the inner superior margin is, in this specimen, wanting or rudimentary. On the lower surface there is a broad longitudinal elevation, which is mainly outside the median line. The basioccipital is stout, and uniformly convex transversely. The axis is elongated, and rather slender. The hypapophyses of the cervicals are simple, compressed, and elongated. In the anterior cervicals they are directed forward, but in the eleventh vertebra, this process is perpendicular. The articular cup is here a very broad transverse oval. The dorsal scutes were articulated.

*Measurements.*

| | | |
|---|---|---|
| Transverse diameter of quadrate, at distal end, | 14· | lines. |
| Vertical diameter, on median line, | 3·90 | " |
| Length of axis, with odontoid process, | 22·25 | " |
| Length of eleventh vertebra, from edge of cup to end of ball, | 16· | " |
| Width of cup, | 9· | " |
| Depth of cup, | 8·10 | " |
| Length of hypapophysis, | 5· | " |

This specimen was nearly, but not quite, adult. It was discovered by Mr. C. T. Ballard, of the Yale party, at Grizzly Buttes, near Fort Bridger.

### *Crocodilus affinis*, sp. nov.

The most common fossil Crocodiles in the Tertiary beds of Western Wyoming are large reptiles, having stout conical rugose teeth, with prominent, but rather obtuse cutting edges, not unlike the teeth of the modern North American Alligator. Professor Leidy has recently described, under the name of *Crocodilus Elliotti*,[*] a species with these characteristics, which was found in the eastern part of the same Tertiary lake-basin; but a comparison of his original specimens, which he has kindly loaned the writer for this purpose, with the extensive material obtained by the Yale party near Fort Bridger, show clearly that there are two distinct species, about the same size, and with teeth almost identical. The two may be distinguished, how-

[*] Proceedings Acad. Natural Sciences, Phil., 1870, pp. 100 and 122.

ever, by the premaxillaries, which in the skull described by Professor Leidy are elongate, and have, to the entire length of the skull, a ratio of about one to three. In the second species, to which the name preceding this description may be given, the corresponding parts have the approximate ratio of one to four, as shown by a very perfect skull in the Yale Museum, as well as by other remains which give all the essential characters. The symphysis in this species is quite short, and, at the posterior upper margin, is met by the anterior extremity of the splenial. The nasal bones project forward, and form a septum in the external nostril, as in the Alligator. The cervical vertebræ, moreover, have hypapophyses resembling those in that genus. The quadrate is much constricted at its distal articular end. Its lower surface is concave, with a sharp longitudinal ridge, exterior to the median line.

*Measurements.*

| | | |
|---|---|---|
| Length of skull, on upper surface,........... | 13 inches, | 9· lines. |
| Length of premaxillaries,................... | 3 " | 6· " |
| Transverse diameter of quadrate, at distal end, | | 22·50 " |
| Vertical diameter, on median line,......... | | 7· " |

The precise relations of this species to *C. aptus* Leidy, which was described from a single cervical vertebra, cannot at present be decided.

The known specimens of the present species were collected by Mr. H. D. Ziegler, Mr. A. H. Ewing, Mr. E. Whitney, and the writer, at Grizzly Buttes, Wyoming.

### *Crocodilus Grinnelli*, sp. nov.

This species, which was of medium size, closely resembles the preceding in the form and proportions of the quadrate, but differs from it in the more slender jaws, and the more compressed, pointed, and grooved teeth. The symphysis is also longer, and the splenial does not reach it. The basioccipital is transverse, slender and elongate, with a deep vertical groove on the median line. The axis is quite slender, and has two deep, elongated pits, side by side on the floor of the neural canal, and two, less deep and more separated, on the superior surface of the odontoid process. All the vertebræ are strongly striated on the margins of the articular faces. The scutes are free, and with few pits. The specimen here described appears not to have been fully adult, although nearly so.

*Measurements.*

| | | |
|---|---|---|
| Length of symphysis,...................... | 2 inches, | 8·5 lines. |
| Greatest depth,........................... | | 9·25 " |
| Transverse diameter of quadrate, at distal end, | | 16·75 " |
| Vertical diameter, on median line,.......... | | 4·80 " |
| Length of axis, with odontoid process,....... | | 21·75 " |

This species is named for the discoverer, Mr. G. B. Grinnell, of the Yale party, who found a nearly perfect skeleton on Marsh's Fork, in Wyoming. The geological horizon is essentially the same as in the three preceding species.

### *Crocodilus brevicollis*, sp. nov.

A number of cervical and dorsal vertebræ, found together, and evidently belonging to the same individual, differ so much from any known Crocodilian remains that they may be considered specifically distinct. Among the most noticeable characters exhibited, are the relative shortness of the atlas and its attached odontoid process; and the presence, on or near the median line of the lower surface in all the vertebræ preserved, of a deep elongated pit, which has a tendency in its forward extension to produce bifid hypapophyses. The eleventh vertebra has the process thus divided. Its diapophyses are also much elongated, and entirely above the line of the neural arch suture. The articular faces are here broadly oval.

#### *Measurements.*

| | | |
|---|---|---|
| Length of axis, with odontoid process, | 20·5 | lines. |
| Depth of odontoid process, | 9·40 | " |
| Length of process, | 6·30 | " |
| Length of eleventh vertebra, from edge of cup to end of ball, | 16· | " |
| Greatest distance between diapophyses, | 21· | " |

These specimens were found by Mr. A. H. Ewing, in the Tertiary beds, at Grizzly Buttes, Wyoming.

### *Glyptosaurus sylvestris*, gen. et sp. nov.

Among the most interesting Reptilian remains discovered by the Yale party in the fresh water Tertiary deposits of western Wyoming, were several species of Lacertidæ, or land lizards, of which no fossil representative had at that time been found in this country, although more recently one species has been described by Professor Leidy from the same formation. These remains were found associated with the crocodiles and serpents, already described,* and, together with them, strikingly illustrate the remarkable development of reptilian life during the Tertiary period in one of the great tropical lakes of the Rocky Mountain region.

The specimens discovered evidently represent a peculiar genus of lizards, quite different from any known recent or fossil forms, but in the present preliminary notice only the most marked characters are given, the more exact determination and affinities of the group being reserved for the full description. The head in this genus, for which the name *Glyptosaurus*† is proposed, was covered with large osseous shields, symmetrically arranged, and highly ornamented, resembling in this respect the modern *Heloderma.* Other parts of the body, especially the ventral region, were protected by rectangular, ornamented shields, united to each other by suture, and, in some of the species, these were carinate. The teeth are pleurodont, and, in the species in which they are preserved, are round, with obtuse summits, not unlike those of *Trachydosaurus rugosus* Gray, from Australia. The frontals show, especially in front, a distinct median suture, which forms a slightly obtuse angle with their posterior margin. The articular bone projects behind the cotylus far backward and downward, resembling in this respect the corresponding part in *Varanus Niloticus.* The dorsal and caudal vertebræ have the same general form as those of *Varanus*, but show traces of a zygosphene articulation, especially in their rudimentary zygantral cavities. The tail was long, and apparently rounded. Some of the species were larger than any existing American lizards.

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* This Journal, vol. i, May, 1871, p. 322.

† Γλυπτὸς, *embossed*, and Σαῦρος, *lizard.*

The known species of the present genus may be distinguished from *Saniva ensidens* Leidy,* by the teeth, which in the latter are compressed, pointed, and have sharp cutting edges. There is, moreover, no evidence that this lizard had osseous dermal shields.

The position, form, and ornamentation of the cranial shields will perhaps afford the most convenient and satisfactory characters for distinguishing the species represented in the present collection of lacertian remains, which, although numerous, are more or less fragmentary. The present species may therefore be characterized as having, on the frontals between the orbits, shields of moderate thickness, but little elevated, with those in the middle row on each frontal broader than long. Each shield is covered with numerous small polished tubercles, crowded together with no definite arrangement. Ventral shields with the same ornamentation were found with some remains of this species, and probably belong with them.

***Measurements.***

| | | |
|---|---|---|
| Width of single frontal, at posterior margin, ........... | 7·80 | lines. |
| Width of single frontal, between orbits, ................ | 5·30 | “ |
| Length of five posterior shields on middle row of frontal, | 9· | “ |
| Length of fragment of jaw bearing three teeth, ........ | 4·10 | “ |
| Length of ventral shield, probably of this species, ..... | 8·40 | “ |
| Width of the same, .................................... | 4·75 | “ |

The present specimens indicate a reptile about four feet in length. They were discovered by Mr. C. T. Ballard and the writer, at Grizzly Buttes, near Fort Bridger, Wyoming, in the same beds that contained the Crocodilian remains.

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* Proceedings Philadelphia Acad. Nat. Sciences, 1870, p. 124.

### *Glyptosaurus nodosus*, sp. nov.

In this species, which was somewhat smaller than the one above described, the frontals are thicker at the median suture, and the shields between the orbits very convex. The middle row of each frontal in this region has the shields longer than wide, and subhexagonal. The tubercles on the shields are also proportionally larger, and less crowded together. The plates of the body have the same ornamentation as the cranial shields, and some of them are keeled. The species was about three feet in length.

*Measurements.*

| | | |
|---|---|---|
| Width of single frontal, between orbits, | 4·50 | lines. |
| Length of four shields on middle row of frontal, | 8·60 | " |
| Length of ventral shield, | 7·10 | " |
| Width, | 3·40 | " |
| Length of dorsal vertebra, from edge of cup to end of ball, | 5·60 | " |
| Width of cup, | 3·75 | " |
| Depth of cup, | 1·95 | " |
| Expansion of posterior zygapophyses, | 5·60 | " |

The specimens representing this species were discovered by the writer, in the fresh-water Tertiary strata, at Grizzly Buttes, Wyoming.

### *Glyptosaurus ocellatus*, sp. nov.

The present species, which was perhaps the largest of the lizards collected by our party, is readily distinguished from the two preceding, by the pattern of ornamentation on the cranial plates, which are very thick, united by suture, and have the tubercles arranged in concentric series. The outer row of tubercles is considerably the largest, and the next two or three successively smaller; while the center is occupied by a group of very small tubercles, with no definite arrangement. The effect of this is to produce an ocellated appearance in each shield, which has suggested the specific name. This effect is increased in one very perfect specimen by the central group of tubercles being of a lighter color.

The only specimens that can at present be referred with certainty to this species were discovered by Mr. H. B. Sargent, in the Tertiary beds at Grizzly Buttes, near Fort Bridger.

### *Glyptosaurus anceps*, sp. nov.

A small species of lizard, quite distinct from those described above, is indicated by numerous fragmentary remains found associated with them in the same deposits. Some of the characters exhibited by these specimens point toward a different genus, but until additional material is obtained, the species may appropriately be placed in *Glyptosaurus*. The vertebræ have the cup and ball equally transverse with those of the species already described, but they are much less inclined from a vertical. The neural arch is also less elevated in the specimens preserved, and the whole vertebra is more depressed. The teeth are pleurodont. The species was about two feet in length.

*Measurements.*

| | | |
|---|---|---|
| Length of posterior dorsal vertebra, from edge of cup to end of ball, | 2·80 | lines. |
| Width of cup, | 2· | " |
| Depth of cup, | 1· | " |
| Expansion of anterior zygapophyses, | 4·30 | " |

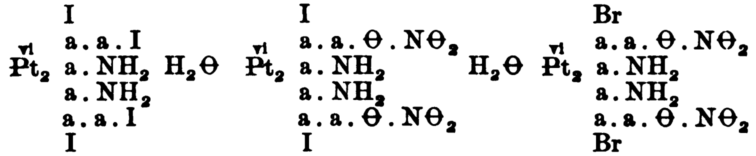
The remains on which the present description is based were collected by Mr. C. T. Ballard and the writer, in the Tertiary beds, at Grizzly Buttes, Wyoming. They are now in the Peabody Museum of Yale College, as are all the other specimens described in the present article.

Yale College, New Haven, May 5th, 1871.

## SCIENTIFIC INTELLIGENCE.

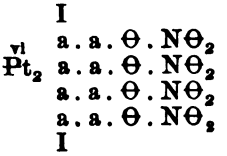
### I. Chemistry and Physics.

1. *On a new series of ammonia-platinum bases.*—P. T. Cleve, to whom we owe an elaborate and valuable investigation of the compounds of platinum with ammonia, has discovered a new and remarkable series in which two atoms of tetratomic platinum combine to form the hexatomic diplatinum. These compounds are formed by treating the iodide, iodonitrate and bromonitrate of Gros's base with ammonia, so that we have the formulas $\mathrm{Pt_2\,a_8\,I_4\,\Theta}$,* $\mathrm{Pt_2\,a_8\,I_2\,\Theta_3\,2N\Theta_2}$, and $\mathrm{Pt_2\,a_6\,.\,2NH_2\,.\,\Theta_3\,.\,2N\Theta_2}$, or rationally according to Blomstrand's views:



$$\overset{\text{vi}}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{I}\\ \mathrm{a.a.I}\\ \mathrm{a.NH_2}\\ \mathrm{a.NH_2}\\ \mathrm{a.a.I}\\ \mathrm{I}\end{array}\mathrm{H_2\Theta}\qquad \overset{\text{vi}}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{I}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.NH_2}\\ \mathrm{a.NH_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{I}\end{array}\mathrm{H_2\Theta}\qquad \overset{\text{vi}}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{Br}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.NH_2}\\ \mathrm{a.NH_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{Br}\end{array}$$

The unsaturated nitrates of the new platinum bases take up $\mathrm{H\,.\,\Theta\,.\,N\Theta_2}$ directly, and give the saturated iodonitrate or bromonitrate:



$$\overset{\text{vi}}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{I}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{I}\end{array}$$

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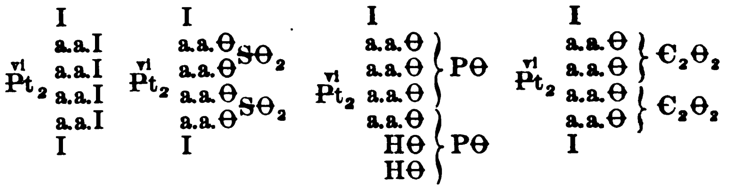
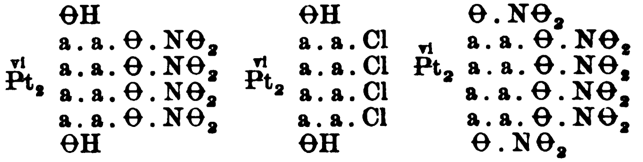
* In all these formulas *a* is the symbol for ammonia.

With iodide of potassium, sulphuric acid, sodic phosphate and ammonic oxalate we obtain:



$$\overset{vi}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{I}\\ \mathrm{a.a.I}\\ \mathrm{a.a.I}\\ \mathrm{a.a.I}\\ \mathrm{a.a.I}\\ \mathrm{I}\end{array}\qquad \overset{vi}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{I}\\ \left.\begin{array}{l}\mathrm{a.a.\Theta}\\ \mathrm{a.a.\Theta}\end{array}\right.\mathrm{S\Theta_2}\\ \left.\begin{array}{l}\mathrm{a.a.\Theta}\\ \mathrm{a.a.\Theta}\end{array}\right.\mathrm{S\Theta_2}\\ \mathrm{I}\end{array}\qquad \overset{vi}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{I}\\ \left.\begin{array}{l}\mathrm{a.a.\Theta}\\ \mathrm{a.a.\Theta}\\ \mathrm{a.a.\Theta}\end{array}\right\}\mathrm{P\Theta}\\ \left.\begin{array}{l}\mathrm{a.a.\Theta}\\ \mathrm{H\Theta}\\ \mathrm{H\Theta}\end{array}\right\}\mathrm{P\Theta}\end{array}\qquad \overset{vi}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{I}\\ \left.\begin{array}{l}\mathrm{a.a.\Theta}\\ \mathrm{a.a.\Theta}\end{array}\right\}\mathrm{C_2\Theta_2}\\ \left.\begin{array}{l}\mathrm{a.a.\Theta}\\ \mathrm{a.a.\Theta}\end{array}\right\}\mathrm{C_2\Theta_2}\\ \mathrm{I}\end{array}$$

Other salts of the same series are:

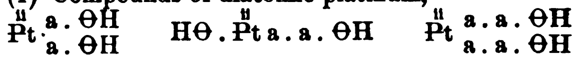


$$\overset{vi}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{\Theta H}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{\Theta H}\end{array}\qquad \overset{vi}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{\Theta H}\\ \mathrm{a.a.Cl}\\ \mathrm{a.a.Cl}\\ \mathrm{a.a.Cl}\\ \mathrm{a.a.Cl}\\ \mathrm{\Theta H}\end{array}\qquad \overset{vi}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{\Theta.N\Theta_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{a.a.\Theta.N\Theta_2}\\ \mathrm{\Theta.N\Theta_2}\end{array}$$

The analogy between these compounds and those of hexatomic cobalt will be at once evident.

In conclusion, the author gives the following view of the platinum bases at present known:

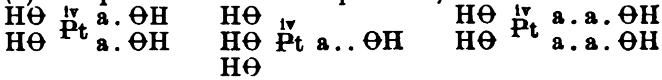
(1) Compounds of diatomic platinum,



$$\overset{ii}{\mathrm{Pt}}\begin{array}{l}\mathrm{a.\Theta H}\\ \mathrm{a.\Theta H}\end{array}\qquad \mathrm{H\Theta.\overset{ii}{Pt}a.a.\Theta H}\qquad \overset{ii}{\mathrm{Pt}}\begin{array}{l}\mathrm{a.a.\Theta H}\\ \mathrm{a.a.\Theta H}\end{array}$$

Reiset's second. Platinous oxide ammonia. Reiset's first.

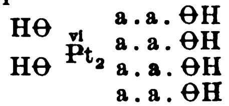
(2) Compounds of tetratomic platinum,



$$\begin{array}{l}\mathrm{H\Theta}\\ \mathrm{H\Theta}\end{array}\overset{iv}{\mathrm{Pt}}\begin{array}{l}\mathrm{a.\Theta H}\\ \mathrm{a.\Theta H}\end{array}\qquad \begin{array}{l}\mathrm{H\Theta}\\ \mathrm{H\Theta}\\ \mathrm{H\Theta}\end{array}\overset{iv}{\mathrm{Pt}}\ \mathrm{a..\Theta H}\qquad \begin{array}{l}\mathrm{H\Theta}\\ \mathrm{H\Theta}\end{array}\overset{iv}{\mathrm{Pt}}\begin{array}{l}\mathrm{a.a.\Theta H}\\ \mathrm{a.a.\Theta H}\end{array}$$

Platinamine. Salt of platinoxide. Gros's base.

(3) Compounds of hexatomic platinum,



$$\begin{array}{l}\mathrm{H\Theta}\\ \mathrm{H\Theta}\end{array}\overset{vi}{\mathrm{Pt}}_2\begin{array}{l}\mathrm{a.a.\Theta H}\\ \mathrm{a.a.\Theta H}\\ \mathrm{a.a.\Theta H}\\ \mathrm{a.a.\Theta H}\end{array}$$

In these compounds ethylamine, aniline, and doubtless other organic alkaloids may replace ammonia to a greater or less extent. —*Berichte der Deutschen Chem. Gesellschaft*, iv *Jahrgang*, p. 70. (From a letter of C. W. Blomstrand.) W. G.

2. *On the preparation of hydric phosphide for lecture experiments.*—A. W. Hofmann has given a simple and elegant method of preparing pure hydric phosphide by means of iodide of phosphonium, $PH_4I$, which is itself easily prepared by the following process due to Baeyer. Dry carbonic disulphide is introduced into a tubulated retort, 100 gr. of phosphorus dissolved in it, and then 175 gr. iodine added in small portions at a time. The disulphide is then to be distilled off and the last traces removed by a current of dry carbonic dioxide, the retort being gently warmed. After cooling, the condenser is to be removed from the retort and

a long, wide and thin glass tube adapted to it, terminating in a gas tube which nearly reaches the surface of the water in a flask. 50 gr. of water are then to be poured in small portions at a time upon the iodide of phosphorus through a funnel tube drawn out at the end. Every time that water is added a violent reaction ensues and iodide of phosphonium condenses in the wide glass tube, while small quantities of iodhydric acid are condensed in the water of the flask. After all the water is added, the retort is at first gently warmed, and afterward heated to low redness so as to drive all the iodide into the glass tube. On breaking the glass tube after cooling, the iodide of phosphonium is found in thick crusts like sal-ammoniac, and with the quantities of material above mentioned amounts to about 120 gr. The iodide as thus prepared is mixed with small pieces of glass and introduced in pieces of the size of a pea into a flask provided with a rubber stopper, through which pass a funnel tube with a stop cock and bulb, and a delivery tube. If now a solution of caustic potash, of the strength of that commonly employed in organic analysis, be allowed to flow down upon the iodide, a regular current of hydric phosphide, $PH_3$, is evolved, which is completely under control. The gas is perfectly pure; 7·3 gr. of the iodide yield about one liter of gas. The gas is not spontaneously inflammable, but becomes so by passing through nitric acid which contains a trace of nitrous acid. Hofmann recommends as a beautiful lecture table experiment the decomposition of pure hydric phosphide by means of the induction spark passing between points of gas-carbon.—*Berichte der Deutschen Chem. Gesellschaft, Jahrgang* iv, p. 200. W. G.

3. *On the direct substitution of the alcohol radicals for the hydrogen in hydric phosphide.*—Absolute alcohol heated with iodide of phosphonium yields hydric phosphide, ethylic iodide and water. HOFMANN has employed this reaction in a beautiful process for obtaining the iodides of triethyl and tetrethyl-phosphonium, which consists in simply heating one molecule of iodide of phosphonium with three molecules of absolute alcohol in a sealed tube for 6–8 hours at 180° C. Under these circumstances the ethylic iodide acts directly upon the hydric phosphide to form the iodides of the substituted phosphoniums. After cooling, the tube is found filled with a beautiful snow-white, crystalline mass, which dissolves in water to a perfectly colorless solution. The crystals are a mixture of about equal proportions of the iodides of triethyl and tetrethyl-phosphonium. A solution of sodic hydrate separates triethyl-phosphine as a colorless layer of liquid. The solution then gives, on evaporation, beautiful crystals of the iodide of tetrethyl-phosphonium; the triethyl-phosphine as separated by means of a funnel is chemically pure. The iodides of trimethyl and tetramethyl-phosphonium were easily prepared by the same process. In like manner allylic alcohol, phenol and glycerin gave promise of a rich harvest of new results.—*Berichte der Deutschen Chem. Gesellschaft*, iv *Jahrgang*, p. 205. W. G.

4. *On a new mode of formation of Para-oxybenzoic Acid;* by Ira Remsen, Assistant in the Chemical Laboratory at Tübingen. (Communicated for this Journal.)—A short time since Barth[*] showed that by fusing sulphobenzoate of potassium with caustic potash oxybenzoic acid is formed. Subsequently Heintz[†] employed this reaction for the purpose of preparing oxybenzoic acid in larger quantity. The fact appears however to have escaped the notice of these chemists, that under the given circumstances paraoxybenzoic acid is likewise always formed, together with oxybenzoic acid, at times even in very considerable quantity.

I was occupied, according to the prescribed directions, in the preparation of oxybenzoic acid, which I required in an absolutely pure condition. On dissolving the first product in water, however, and allowing to crystallize, I was astonished to find that, as the solution cooled, somewhat discolored though well formed crystals, which presented the general appearance of paraoxybenzoic acid, were deposited. Recrystallized from water, these crystals became perfectly colorless and translucent. They were also more perfectly developed than at first, and the crystalline form, as well as could be determined without the aid of measurements, was identical with that of paraoxybenzoic acid. On subjecting this substance to a closer examination, its identity with paraoxybenzoic acid soon became evident. Dried at 100° the crystals became white and opaque from loss of water of crystallization. They fused at exactly 210°, and became solid at 165°. Heated above the fusing point they soon underwent decomposition. The perfect correspondence of these properties with those of paraoxybenzoic acid proves the identity beyond a doubt. The mother liquor from the first crystals yielded on evaporation a mixture, consisting of oxybenzoic and paraoxybenzoic acid, which, although crystallized out together could very readily be distinguished from each other. The latter presented itself, as usual, in the form of well developed crystals, and upon these the oxybenzoic acid had been deposited in the peculiar crystalline masses in which it is generally observed. In this case about equal quantities of the two acids had been generated.

It must be mentioned that the sulphobenzoic acid made use of in this experiment was prepared according to a method somewhat different from that usually employed. The vapors of sulphuric anhydride were conducted into a flask containing crystallized benzoic acid. As, however, after a space of time the benzoic acid became packed together in tenacious lumps, and thus resisted the further action of the anhydride, a small amount of fuming sulphuric acid was added to the mass, and the whole gently heated for a short time. On now diluting with water no benzoic acid separated.

It appeared to me possible that the method of preparation might exert an influence upon the nature of the resulting product. Hence I prepared sulphobenzoic acid according to the method

[*] Ann. de Chemie u. Pharm., cxlviii, 30.

[†] Ibid., cliii, 326.

described by Barth in his article (i. e. by the action of sulphuric anhydride upon fused and pulverized benzoic acid), and tried the same experiment with the potassium salt of this acid. The only difference that made itself evident in the result was that less paraoxybenzoic acid was present in the product than in the former case, though by no means an inconsiderable quantity.

Finally, I subjected to the same process sulphobenzoic acid, that was prepared by simply heating benzoic acid with weak fuming sulphuric acid, and found that also in this case a mixture results, as was to be expected after the two previous experiments.

The two acids cannot be separated by means of partial crystallization. If the aqueous solution was not too dilute, the first portion that crystallized out contained, in the two last cases, the greater part of the oxybenzoic acid probably mixed with a little paraoxybenzoic acid. On evaporating the mother liquor further, about equal parts of the two acids crystallized out. The crystals of paraoxybenzoic acid could now be partially sorted out, and thus separated from the accompanying acid.

The preparation of the basic barium salt of paraoxybenzoic acid furnishes a means for an imperfect separation. This salt, as was shown by Barth,* is difficultly soluble in water, and is precipitated when baryta water is added to a solution of the neutral salt, whereas by this means no basic salt of oxybenzoic acid is produced. In this way a portion of the paraoxybenzoic acid can be obtained in a pure condition. There always remains a sufficient quantity of the salt in solution, however, to render the oxybenzoic acid useless for decisive experiments.

An attempt to employ the different properties of the cadmium salts of the two acids for the purpose of separation led to no favorable result.

It follows from the above experiments, that for the preparation of *pure* oxybenzoic acid, *crude* sulphobenzoic acid cannot be employed. It will be necessary to subject it to some process of purification. The simplest means that presents itself for this purpose is the preparation of the acid barium salt.

I am at present occupied in endeavoring to isolate and learn the properties of the sulpho-acid, the formation of which is in all probability the prime cause of the formation of paraoxybenzoic acid, and to determine the most favorable conditions for its formation. I shall also more carefully study certain uncommon phenomena, which can possibly be traced back to this, that the fact above discussed has up to the present been overlooked.

Tübingen, Germany, March, 1871.

5. *New Spectroscopic Combination;* by P. A. Secchi. (In a letter to Prof. Silliman, dated Rome, April 19, 1871).—I have the honor to announce to you the discovery of a new spectroscopic combination, by the aid of which one can see the images of the spots and of the solar protuberances with the spectral lines all at once in the same field.

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* Zeitschrift für Chemie, N. F., ii, 646.

This result is reached by two methods; 1st, by placing before the objective of the telescope, a prism as large as that which I employ for star spectra, say of six inches opening, and causing the colored image which is produced at the focus of the lens to fall upon the slit of the ordinary spectroscope.

2d. The other method, less costly, consists in placing a direct vision prism of a high dispersive power in the path of the luminous rays before they arrive at the focus, and over the slit of the common spectroscope.

By these two methods is obtained in the field of the spectroscope, the solar image formed of different colored shades, with their spectral lines, but very sharply defined with their spots and margins quite exact, so that the details of the spots can be examined as with a colored glass.

If the sun's limb falls near the line C, which as we have just said, is seen at the same time as the image of the sun's limb, we see the chromosphere and the prominences showing themselves as brilliant lines more or less elongated from the sun's limb, according to the height of the prominences. The narrower the slit the sharper the image of the spots.

Thus the protuberances are seen as brilliant lines, but their form is recognized only by linear sections as in the old method of Janssen. Nevertheless their height can be perfectly recognized and measured. by measuring the distance from where the line C becomes brilliant to that point on the sun's limb, which is upon the same normal to the limb. By opening the slit the form of the protuberances can also be recognized, but only with a loss of precision of definition. By a narrow slit the height and position of the protuberances can be recognized and measured with the greatest precision, and their position fixed with reference to the spots and faculæ, in a manner far more simple and certain than with the ordinary spectroscope.

If in a spot there is a jet of hydrogen, C is at once seen to become more brilliant or at least the darkness is diminished, and the lines of calcium and of iron become broader, &c., as in ordinary observations, but with far greater satisfaction and certainty of position.

I have observed the spectrum of the little comet of Winnecke, and I have found a band in the green similar to that in the other comets.

6. *Lessons in Elementary Physics;* by Balfour Stewart, L.L.D., F.R.S., Professor of Natural Philosophy, Owens College, Manchester. London, (Macmillan & Co.). 1870.—This little work is by no means the common-place, second hand compilation that elementary books so often are, but a careful and thorough digest of the facts and principles of Physics, by one not only a master of his subject, but himself an original investigator. Its characteristic excellence is, that it exhibits in a compact, yet elementary form the freshest aspects of physical science, particularly as related to the doctrine of energy, so successfully developed within a few

years by the labors of Thompson, Rankine, Mayer, Clausius, and others. This doctrine runs consistently through the work, and lies at the basis of the explanations of the most important phenomena of heat, sound, light, electricity, etc. Indeed this little book is one of the best elementary expositions within our knowledge of the modern views respecting energy and its transformations, and we can heartily commend it to the attention of teachers, and of all who desire, in a small compass, a clear and consistent exhibition of the outlines of modern physical science.

## II. Geology and Natural History.

1. *Lesquereux on Illinois Coal Plants, in the 4th vol. of the Report of the Geological Survey of Illinois.*—In the closing portion of Mr. Lesquereux's report on the Illinois coal-plants, the author treats of the larger groups here represented, and, while finding evidence against the existence of *Fungi* and *Lichens*, acknowledges the presence of *Conifers* (recognized by leaves and fruit, though not by woody fiber), besides the abundant *Equisetaceæ*, *Filices* and *Lycopodiaceæ*. He argues strongly for the uniformity, in character of vegetation, of the high and low land of the Carboniferous period, and concludes that there is no reason to believe that any prominent types existed which are not found in or near the coal beds. While denying that any remains of *Algæ* occur in or immediately over the beds of coal, he acknowledges their presence in sandstones and limestones near the base of the Coal-measures, both in Pennsylvania and in Indiana. His language implies what we learn to be true, that he had not seen the specimens of *Caulerpites* from Vermillion and Edgar counties of Illinois, mentioned in Prof. Bradley's reports on those counties, in the very volume under review, as occurring in a sandstone above the horizon of Coal No. 7, or at least as high as the middle of the Coal-measures. Similar forms were reported by G. C. Broadhead from the Missouri measures, though here again from the very base of the series. (See Tr. Ac. St. Louis, ii, 329, 1865.) S. W. Ely of Cincinnati also reports them from the Cumberland table-land; though, because of their character, he refers them to Devonian rocks, which do not exist there. Their position in the measures is in this case uncertain, though probably low. A locality in Indiana, not mentioned by Mr. Lesquereux, is in a heavy bed of sandstone outcropping along the bank of the Ohio river, a few miles below Cannelton.

Finding, in the ironstone nodules of Mazon creek and similar localities, various organs and parts of plants not elsewhere recognized, the author attributes their preservation to their mode of fossilization, implying that, in the softer rocks, these more delicate tissues perished before the rocks were solidified. We are more inclined to believe that their apparent absence from such beds is due merely to the greater difficulty of separating the rock from any but the broader and smoother surfaces.

"Besides two of the species described in the genus *Staphylopteris*," which has the fruit in a raceme on a separate stalk, "we have, in nodules from Mazon creek, seven fruiting species of *Alethopteris*, six of *Pecopteris*, and one *Asterocarpus*." Many others show the fruit-dots, through the tissue of the fronds, too indistinctly to be accurately made out—indicating "a proportion of fruiting branches [fronds] nearly as marked as it would be in collecting ferns of our time in a given area." *Neuropteris*, though plainly an herbaceous genus, and most beautifully and perfectly preserved, at many localities, and in great numbers, has not shown its fruiting.

Rhizomas of fossil ferns have been very rare; but we here find reported "numerous specimens of eight species." "It is therefore apparent that the organs of the ferns of the Carboniferous period were the same and in the same proportion as those of our times." "The roots of *Lepidodendron* are unknown as yet; and I believe that some species of this genus heretofore considered as branches of trees are mere creeping stems which, in some circumstances only, bear flowering stems or true *Lepidodendra*. It is the same with *Sigillaria*, the species of which I consider as fruiting stems of *Stigmaria*." "Remains of *Stigmaria* fill whole banks of fire-clay * * to a thickness of from six to fifty feet; and no remains of *Sigillaria* have ever been found in this clay in connection with them. Roots cannot live by themselves, independent of any other kind of organs, and it is certainly impossible to explain the mode of vegetation, the form, the nature of the *Stigmaria* and its action, in considering it as a root. But admitting these plants to be the floating stems of species of *Sigillaria* to which they have been sometimes seen attached, their peculiar nature and mode of vegetation become explainable, and in circumstances where they are found in the Coal-measures, they are in perfect harmony with the general vegetation of that epoch, as well as with the end which they were called to achieve. As is the case especially with our floating mosses, these floating stems of the Carboniferous epoch have the characters blended in a kind of uniformity which renders them scarcely recognizable. All the *Stigmaria* bear the same kind of cylindrical, bladdery leaves, and therefore have all, though belonging to different species, the same kind of cicatrices upon their stems, viz. a circular, double ring, with a single vascular scar in the center."

"It is evident that species of *Sigillaria* have sometimes grown in sand; and I believe that, under such circumstances, their subterranean divisions have somewhat modified their form, and have become similar to roots."

"Botanical palæontology is a peculiar science. It offers to its adepts mere fragments of organs, whose relation to a whole is mostly unknown, forcing him either to generalize and to consider in one species a number of organs which evidently pertain to plants of various kinds, or to specify and to divide under divers genera and species fragments which, if not evidently, at least often apparently, belong to the same vegetable. It is not surprising that opinions concerning these remains are often at variance and often modified, or that the student of these fossil remains becomes discouraged by the sterility of his researches."

"European palæontologists, who have especially studied the fossil plants of the Carboniferous strata, Brongniart, Göppert, Schimper, Geinitz, etc., have admitted that the distribution of these plants is modified according to the age of each bed of coal, and that, therefore, the horizontal position of the coal strata may be recognized by species peculiar to each. These views, as it now appears,* have been advanced on theoretical ground, or are based on local observations which cannot be considered as furnishing conclusive proofs; for local modifications in the succession of species of plants may be the result of mere local atmospheric or geographical changes which do not affect the characters of the whole flora, and therefore the comparative distribution of the fossil species of plants of an epoch cannot be ascertained but from the examination of this flora over the whole extent of its domain."

The author is not prepared to abandon the theory of the "stratigraphical distribution of the fossil plants of the coal," because, first, "in a theoretical point of view, it is scarcely admissible" that throughout the long succession of alternating conditions evidenced by the Coal-measures "the flora has been represented by the same species distributed in the same proportion;" and, secondly, "the fossil plants hitherto obtained are mainly the results of local researches too limited to serve as a basis for general conclusions." When more extended examinations and complete collections have been made, "we shall have sufficient proofs of a gradual change in the characters of the vegetation of the Coal-measures from the first appearance of land vegetation."

The *Lycopodia*, beginning in the Devonian "by the number of species and size of trees," attain their full development near the base of the Coal-measures, and then decrease in numbers, though very slightly in size, to Coal No. 5 of the Illinois valley section, above which "*Lepidodendra* have not as yet been found."

"From horizons above the Pittsburgh coal we know nothing as yet of the flora of our Coal-measures." But Göppert finds *Lepidodendron* as high as "the lowest strata of the Permian" in Europe.

"The fruits described under the generic names of *Trigonocarpus*, *Rhabdocarpus* and *Ptilocarpus*, have as yet been found only from the Sub-conglomerate coal strata upward to Coal No. 2. They abound in the millstone grit and the hearth sandstone as in the shale of Coal No. 2. A few fruits of uncertain affinity, and considered under the name of *Carpolithes*, have been observed higher in the measures. As yet these cases are very rare."

Of *Neuropteris* some species range from bottom to top of the measures; while others, especially those of coarse or thick nervation or texture, are characteristic of the lowest seams. *Odontopteris* runs "up to Coal No. 2" and to Coal No. 6, as is stated on page 253 of the same volume. "Large thick-leaved species of

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* From the authority of Prof. Brongniart, in letters, 1869.

*Alethopteris*, with *Callipteris Sullivanti*, are said to characterize Coal No. 2. *Sphenopteris* is considered "peculiar to the lower Coal-measures." "As representative of the higher coal strata of Illinois, there is no particular species to quote." "In the anthracite region of Pennsylvania, the highest strata are recognized by the presence of *Pecopteris arborescens*, which has not been as yet positively discovered in Illinois. * * In Europe it ascends to the Permian."

As the *Lycopodia* decreased in numbers and in size, they were "proportionally replaced by ferns."

The relation of the Coal-measures of Illinois to those of Pennsylvania, Rhode Island and Nova Scotia is indicated by the identity of numerous species of ferns. Of the common species of our eastern coal-fields, only one has not yet been found in Illinois. As regards the relation of these beds to the coals of Europe "no genus of our coal flora, except perhaps *Calamites*, can be considered as represented on both continents by species all identical or closely allied. As these points of difference, like those of affinity, have been observed from the beginning of the researches on the coal flora, and have not varied much in comparative quantity, they appear to fully corroborate the statement that, at the Carboniferous epoch, the flora which formed the constituents of the coal was, in Europe and in the United States, as different and at the same time as relatively alike, as is now the flora of the peat bogs of the two continents." F. H. B.

2. *On some points connected with the Cretaceous and Tertiary of North Carolina;* by T. A. Conrad. (From a letter to J. D. Dana, dated Greeville, Pitt Co., North Carolina.)—I have been labelling the collection of fossils at Raleigh, and am now here exploring the marl pits and bank of Tar river. I have heard so much of the mixture of Miocene and Cretaceous fossils, that I was delighted to have an opportunity to see the beds where it occurs. I thought you would like to have a sketch of them. They run from three to five feet deep, and indicate the proximity of a Cretaceous shore, not an Eocene one, for we find only Greensand fossils, and they are extremely rare. The marl is fine sand, mixed with gravel and a profusion of broken shells, some water worn, having evidently been rolled in the surf; but among these fragments is a multitude of entire bivalves and univalves not in the least abraded. In company with Col. Yellowby of this place I was walking over a marl heap, when he picked out of the marl a horse-tooth, which I think is Leidy's *E. fraternus*. Lying on the top of the marl, it had evidently been thrown up from the lower part of the bed, and is black and mineralized. From the numbers which have been found in similar situations I am forced to conclude that the horse was a Miocene quadruped; and if this tooth should prove to have belonged to *E. fraternus*, it will fix the date of the Pea-shore clay near Philadelphia. Prof. Kerr has a new *Busycon*, eight inches long, which connects the two genera *Busycon* and *Sycotypus*, for it would belong to the latter if it had a distinct

canal at the sutures, but it has only a depression there. He has also a Mastodon jaw with two teeth on each side and two straight tusks projecting from the lower jaw. This, although found on top of the marl, I believe to have been a Miocene species, drifted on the marl by the rush of waters at the close of the period.

In the drift over the marl among sand and gravel on the shore of Tar river are great numbers of shark teeth, water-worn, mixed with water-worn fragments of friable granite. There is no material variation of the beds from those of New Jersey and Maryland by which a doubt of their synchronous deposition could be sustained, and a very few species are so like the recent ones that they might pass for the same. The same colossal Pectens abound as in Virginia, only the *P. Madisonius* so abundant in Virginia and Maryland is replaced by *P. Jeffersonius* and *P. septenarius*, five or six inches in width.

At Col. Yellowby's marl pit where digging is now in progress, I found the Miocene about three or four feet in thickness, resting on black Cretaceous sand with black gravel, and containing characteristic Ripley group fossils. It is here that a profusion of Belemnites is thrown up by the laborers, over the Miocene marl heap, and give rise to the opinion that they occur in the Miocene marl.

At Snow Hill, twenty-two miles from here in Green county, the Ripley Group is finely developed, containing closely packed specimens of the Ripley species in perfect preservation.

3. *On the Earthquake at Oahu, Hawaian Islands, on Feb.* 18; by Professor W. D. Alexander. (From a letter to J. D. Dana, dated Oahu College, Feb. 28, 1871.)—I herewith send you some copies of our island papers containing accounts of a severe earthquake, which was experienced here on the 19th of this month. It was the severest earthquake ever experienced on the island of Oahu within the memory of man. In fact it was quite as severe here as on Hawaii, and seems to have been felt most severely at Lahaina. As I am not quite satisfied with the accounts of it published here, I will add a few facts that I have collected.

In regard to the *time*, Flitner's astronomical clock stopped at $10^h\ 11^m\ 17^s$ P. M., Honolulu mean time, allowing for the error of the clock. In regard to the *duration* of the shock, Rev. G. Williamson, Dr. J. Hutchinson, Judge Hartwell and one or two others who timed it carefully, agree within a few seconds in making it 55 seconds. The general opinion here is that it lasted about a minute, and the same was the case at Lahaina and Hilo.

In regard to the direction of the shock, the motion was chiefly vertical with a rocking movement northeast and southwest. It was compared by some to the sensation of riding a "bucking mustang" or driving a cart over a rough corduroy road. Many stone and adobie buildings were badly cracked, particularly our school house, the large stone church, the Queen's hospital, and the court house, and the northeast and southwest walls were generally most shaken. Stone fences running northwest and southeast were thrown down, while those at right angles to this direction were not injured. Doors facing southwest were swung open, and hanging lamps were left swinging for ten or fifteen minutes in almost every instance in the same direction, viz. from northeast to southwest. Considerable crockery was broken, and heavy articles of furniture displaced. The usual roaring sound preceded this earthquake. Persons who were on board ships in the harbor report that they heard this terrible roaring sound far out at sea, and then the ships that lay farthest out were first struck and afterward those that lay at the wharves. They agree that the vessels were first drawn violently out to sea and then in the opposite direction.

Several persons of undoubted veracity insist that they saw a flash of light on Punchbowl hill the moment before the earthquake commenced. At Waialua at the north end of this island the shock was comparatively slight. At Waianae on the N. W. of this island, the earthquake was severe. Quite a landslip took place, carrying a house several rods. At Koolau, milk was thrown out of pans east and west. The schooner Annie in the channel south of Lanai was terribly shaken, and her bulwarks split amidships.

At Lahaina, as you will see by the papers, the shock was more severe than here, the ground cracked open in many places, and all the stone or adobie houses in the town were badly damaged. Rev. S. E. Bishop of Lahainaluna Seminary gives the time as $10^h$ $15^m$ P. M. The direction of the vibration was from south to north, or according to some from S.E. to N.W.

At Molokai the shock was severe, especially at the western end. The road up the great *pali* of Kalaupapa on the north side was rendered impassable.

At Wailuku, on the east side of West Maui, the earthquake was much less severe, stone walls being thrown down in some places, but no serious damage done. The *time* by my father's clock, which is set by the sun, was $10^h$ $20^m$ P. M., equivalent to about $10^h$ $15^m$ Honolulu mean time. At Makawao on East Maui the shock was slight. At Capt. Makee's, on the S.W. side of Haleakala, it was much less severe than at Lahaina. A train of molasses kettles was displaced, which was about the only damage done. The earthquake along the west coast of Hawaii was almost simultaneous with that experienced here, and about equal to it in severity. From Kohala I learn that the shock seemed to come from the *west*, that some stone walls were shaken down, but the stone church and plantation chimney remained uninjured. We hear the same story from Waimea and Kawaihae. From *Kona*, Mr. Parke writes, that the time of the shock was $10^h$ $5^m$ by his watch (which is probably within five minutes of the true time), that stone walls were thrown down, but no great damage done. At *Hilo* the earthquake was much lighter. According to Judge Hitchcock it took place at $10^h$ $15^m$ P. M., and lasted a minute.

From *Kauai* I hear that it was severe at Koloa on the south side of the island, but less severe and light on the north side at

Hanalei. No earthquake wave of any consequence is reported from any quarter.

The phenomena seem to me to point to a center of disturbance to the leeward of the islands, perhaps at the center of the circle of which the islands form an arc, and at a great depth. But as you see, our *data* are as yet very imperfect. There have been several slight shocks felt here since, on the 22d and 24th. I cannot learn that there is any unusual action going on at Kilauea or in Mokuaweoweo.

I am hoping to commence the survey of these islands next May.

4. *Note on Trimerella acuminata;* by E. BILLINGS. (Communicated by the author).—The genus *Trimerella* was founded by me on two species, *T. grandis* and *T. acuminata;* but of the latter I had only the rostral half of the ventral valve of a small specimen. I therefore named it provisionally and stated that it differed "from *T. grandis* in having the spiral extremity much more pointed, and the longitudinal septa running all the way to the beak." (The septa here alluded to and the walls between the tubes mentioned below). Within the last few days Mr. T. C. Weston, of our survey, discovered several new specimens, among which are two exhibiting the casts of both valves in connection. It then immediately became evident that several separate dorsal valves in our collection belonged to the same species. I have, therefore, now abundant material to illustrate the species, which I shall do soon, but in the meantime propose to notice its leading characters briefly.

The ventral valve, in young specimens, is somewhat straight along the median line, but becomes more and more arched as the size increases. It is ovate, rounded in front, widest a little in advance of the mid-length, thence tapering with nearly straight sides to the beak which is narrowly rounded,—almost acute. In the substance of the shell there are two large tubes, which extend from about the mid-length to the beak. These are joined in the beak by two others, one on each side. All of these tubes are open anteriorly, but closed at their terminations in the beak. The area is large, concave and transversely striated. The dorsal valve is much shorter than the ventral, more convex and has its beak very strongly incurved. It has two tubes which extend nearly to the apex of the beak. The shell is marked with coarse concentric accretion ridges of growth. Length of the largest specimen 3½ inches, width 3 inches. The above is sufficient to show that this species is quite distinct from *T. grandis.* If a section were to be made across the beak of a perfect shell of *T. acuminata*, it would show four perforations arranged in a curve, exactly as in the similar section of the Swedish species figured by Dr. Lindström. But if the beak of *T. grandis* were to be cut across, it would show only two orifices, and they would be the homologues of the two lateral perforations in the section of *T. acuminata*, because in *T. grandis* the two central tubes do not extend into the beak, but terminate before they reach it.

Montreal, May 5th, 1871.

5. *Note on the discovery of the opercula of Hyolithes in New York;* by S. W. Ford. (Communicated by the author).—Several weeks ago, being in Montreal, I showed Mr. Billings, Paleontologist of the Geological Survey of Canada, a small collection of fossils that I had made in the Primordial rocks near this place. He pointed out to me, that among them there were the opercula of two species of *Hyolithes.* One is a minute circular species with four pairs of lateral muscular impressions, and two smaller, dorsal, all radiating from a point near one side. The other species is larger and like a *Discina* on the outside. Mr. B. showed me several specimens of the smaller species, that had been collected by Mr. T. C. Weston of the Canadian Survey last summer, in rocks of the same age below Quebec. I am informed that this is the first discovery of the opercula of *Hyolithes* yet made on this continent. I have made some observations on the rocks of this vicinity, and collected a number of species of fossils, of which I hope to give an account at an early date.

Troy, May 8th, 1871.

6. *Note on a new and gigantic Species of Pterodactyle;* by O. C. Marsh.—In addition to the Cretaceous fossils described pp. 447–453, the Yale College party obtained several specimens which indicate a huge flying reptile, apparently of the genus *Pterodactylus.* The remains belonged to two or more individuals. They are fragmentary, but some of them are quite characteristic. The distal ends of two long bones, similar in form to the tibia of a bird, are evidently portions of the peculiar metacarpal of the wing-finger. One of these, which retains the lower part of the shaft, resembles in its proportions the corresponding bone in *Pterodactylus Suevicus.* The condyles are well developed, and have a sweep of two thirds of a circle. They appear to have been originally somewhat oblique. In size and general form, they are not unlike those of the specimen figured by Owen in his Memoir on Cretaceous Reptiles, 1851 (Sup. I, Pl. IV, fig. 9–11), but there was apparently no longitudinal elevation between them. The shaft, where broken, is subtrihedral, with the posterior face concave. The bones are light, with thin compact walls. The long bones are pneumatic. The teeth are smooth, and compressed. The length of the metacarpal with the part of the shaft preserved is six and one-half inches; the fore and aft extent of the condyles fourteen lines; the transverse extent about thirteen lines. This would indicate an expanse of wings of not less than twenty feet! The species, which is the first found in this country, may be named *Pterodactylus Oweni,* in honor of Professor Richard Owen, of London. The remains now representing it were discovered by the writer, in November last, in the upper Cretaceous formation of Western Kansas.

7. *Earthquakes—Subterranean electrical disturbances.*—A few minutes before and after the earthquakes of the 17th March last powerful positive electrical currents were rushing toward England through the two Anglo-American telegraph cables, which are broken near Trinity Bay, Newfoundland. Mr. C. F. Varley, C.E., who informed us of the fact, broaches the novel speculation that some [illegible]arthquakes may be due to subterranean lightning.—*Nature,* Apr. 20.

8. *Geology of Louisiana.*—The Annual Report of the Board of Supervisors of the Louisiana State University for the year ending Dec. 31, 1870, and session of 1871, contains the Second Annual Report of the Geological Survey of Louisiana to the General Assembly (of the State), by Prof. F. V. Hopkins. It gives a brief account of the geological formations—which do not reach back in time beyond the Cretaceous, and are almost wholly Quaternary and Tertiary—and is accompanied by a colored geological map of the State. Lists of fossils of the beds are given after determinations of the species by Prof. E. W. Hilgard of the Mississippi University.

9. *Preliminary Report of the U. S. Geological Survey of Wyoming and portions of contiguous territories* (being a Second Annual Report of Progress); conducted, under the authority of the Secretary of the Interior, by F. V. Hayden, U. S. Geologist. 512 pp. 8vo. Washington, 1871.—Dr. Hayden during the past year continued the survey of the preceding season, by investigations from Cheyenne to Fort Fetterman, South Pass, Fort Bridger, the Uintah Mountains, Henry's Fork, Green River Station on the Union Pacific Railroad, and back, and obtained important results. In the lower range of hills which extend up to the South Pass on the south side of the Sweet Water, there was a limited area of granite with overlying Potsdam sandstone containing *Obolella nana* and a *Lingula*. Many fossil shells, vertebrates and plants were collected, which are described in special reports appended to the volume severally by F. B. Meek, Dr. J. Leidy, Prof. E. D. Cope, and Mr. Lesquereux, adding very much to the value of the volume. There is also an excellent report on the Tertiary coals of the West by Jas. T. Hodge, another on the ancient lakes of Western America by Prof. J. S. Newberry, and finally, a report on the industrial resources of Western Kansas and Eastern Colorado by Mr. R. S. Elliott.

10. *Lehrbuch der physikalischen Mineralogie;* von Dr. Albrecht Schrauf. Vienna, 1868.—Dr. Schrauf, the able author of the Atlas of Crystalline forms of Minerals noticed on page 220, issued in 1866 and 1868 volumes I and II of a work on Physical Mineralogy, which is a thorough and profound treatise on descriptive and mathematical crystallography, and the optical, thermic, and other physical characters of minerals or inorganic substances. We learn from the author that he has in preparation a third volume, which will be a companion to his Atlas of crystalline forms, and contain tables of the dimensions and angles of the crystals of the various mineral species, supplying all that is needed to make the atlas a complete exhibition of mineral crystallography.

10. *Mineralogische Notizen*, von F. Hessenberg. No. 10 (Neunte Fortsetzunge) with 3 plates of crystalline forms. Frankfort on the Maine 1871.

## III. ASTRONOMY.

1. *On a Sunspot seen with the Naked Eye;* by FRANCIS H. SMITH. (Editorial corresp. dated University of Virginia, Apr. 19, 1871.)—On Friday, the 14th inst, shortly before sunset, I saw, with the naked eye, a large sunspot just above and to the left of the center of the disc. The atmosphere was quite hazy at the time, and one could gaze with impunity upon the sun, which appeared of a bright orange color. The spot came out with remarkable distinctness; as thin horizontal streaks of darker haze passed over the disc, Prof. Peters, who was with me at the time, saw the spot plainly.

Under the same circumstances of position, haze and color, Col. Venable and myself obtained a distinct view of apparently the same spot, which had moved in the interval to the right of the sun's center. The color of the latter was such, that a light blue glass rendered it almost invisible.

I tried in vain earlier in the day, when the sun was nearer the meridian, to detect a spot on it by looking through colored glasses.

Some time after the first occasion mentioned, I examined the sun with a small refracting telescope, and thought there appeared near the indicated position a large spot, with a smaller companion, yet in the absence of micrometric measurement, I would not have thought it large enough to be visible to the naked eye.

2. *Discovery of a new Planet.*—The 113th asteroid has been discovered by Dr. Luther at Bilk. It is of the 11th magnitude and has received the name *Amalthea.*

3. The following *table of the twenty-five small planets previously discovered* may be useful for reference.

| No. | Name. | Time of discovery. | Discoverer. | Mean dist. | Angle of Eccent. | | Incl. | | Long. of node. | | Long. per. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ° | ′ | ° | ′ | ° | ′ | ° | ′ |
| 88 | Thisbe, | June 15, 1866. | Peters. | 2·7659 | 9 | 28 | 5 | 15 | 277 | 47 | 308 | 33 |
| 89 | Julia, | Aug. 6, " | At Marseilles. | 2·5505 | 10 | 22 | 16 | 12 | 311 | 33 | 353 | 14 |
| 90 | Antiope, | Oct. 1, " | Luther. | 3·1368 | 9 | 57 | 2 | 17 | 71 | 20 | 301 | 59 |
| 91 | Aegina, | Nov. 5, " | Borelli. | 2·4917 | 3 | 47 | 2 | 10 | 11 | 42 | 68 | 54 |
| 92 | Undina, | July 7, 1867. | Peters. | 3·1846 | 5 | 52 | 9 | 57 | 102 | 45 | 331 | 13 |
| 93 | Minerva, | Aug. 24, " | Watson. | 2·7536 | 8 | 5 | 8 | 37 | 5 | 4 | 275 | 1 |
| 94 | Aurora, | Sept. 6, " | Watson. | 3·1615 | 5 | 2 | 8 | 5 | 4 | 34 | 45 | 22 |
| 95 | Arethusa, | Nov. 23, " | Luther. | 3·0712 | 8 | 28 | 12 | 51 | 244 | 22 | 30 | 9 |
| 96 | Aegle, | Feb. 17, 1868. | Coggia. | 3·0543 | 8 | 4 | 16 | 7 | 322 | 51 | 164 | 17 |
| 97 | Clotho, | Feb. 17, " | Tempel. | 2·6694 | 14 | 56 | 11 | 45 | 160 | 36 | 65 | 46 |
| 98 | Ianthe, | Apr. 18, " | Peters. | 2·6845 | 10 | 54 | 15 | 33 | 354 | 18 | 147 | 45 |
| 99 | Dike, | May 28, " | Borelli. | 2·8339 | 14 | 3 | 14 | 1 | 41 | 35 | 239 | 9 |
| 100 | Hecate, | July 11, " | Watson. | 3·0964 | 9 | 0 | 6 | 22 | 128 | 27 | 307 | 50 |
| 101 | Helena, | Aug. 15, " | Watson. | 2·5731 | 8 | 1 | 10 | 4 | 343 | 35 | 328 | 41 |
| 102 | Miriam, | Aug. 22, " | Peters. | 2·6609 | 14 | 47 | 5 | 5 | 211 | 37 | 354 | 41 |
| 103 | Hera, | Sept. 7, " | Watson. | 2·7029 | 4 | 39 | 5 | 24 | 136 | 18 | 321 | 57 |
| 104 | Clymene, | Sept. 13, " | Watson. | 3·1798 | 11 | 23 | 2 | 53 | 43 | 47 | 62 | 12 |
| 105 | Artemis, | Sept. 16, " | Watson. | 2·3799 | 10 | 9 | 21 | 39 | 187 | 54 | 242 | 36 |
| 106 | Dione, | Oct. 10, " | Watson. | 3·1623 | 10 | 33 | 4 | 39 | 63 | 15 | 27 | 13 |
| 107 | Camilla, | Nov. 17, " | Pogson. | | | | | | | | | |
| 108 | Hecuba, | Apr. 2, 1869. | Luther. | 3·2134 | 5 | 46 | 4 | 24 | 352 | 20 | 175 | 4 |
| 109 | Felicitas, | Oct. 9, " | Peters. | 2·6941 | 17 | 27 | 8 | 3 | 4 | 56 | 55 | 56 |
| 110 | Lydia, | Apr. 19, 1870. | Borelli. | 2·6931 | 4 | 37 | 6 | 0 | 57 | 4 | 357 | 28 |
| 111 | Ate, | Aug. 14, " | Peters. | 2·5756 | 5 | 49 | 5 | 1 | 306 | 26 | 122 | 53 |
| [illegible] | Iphigenia, | Sept. 19, " | Peters. | 2·4357 | 7 | 16 | 2 | 37 | 324 | 5 | 337 | 43 |

It will be seen that of these twenty-five planets, fifteen were discovered in this country, six in France, four in Germany and one in India. H. A. N.

## IV. Botany.

1. *Flora Brasiliensis.*—Part 50 of the great work of Martius, continued by Eichler, was issued at the close of the last year. It is occupied by Mr. Bentham's continuation of the *Leguminosæ* (viz. *Swartzieæ* and *Cæsalpineæ*), in 254 pages of letter-press, fully illustrated by 66 plates. The *Swartzieæ* form now only the ultimate tribe of *Papilionaceæ*. Among the figures are to be found one of *Guilandina Bonducella* and of a related species, now reduced to *Cæsalpinia*, of *Parkinsonia aculeata*, and of *Cassia Chamæcrista*. There are 189 Brazilian species of *Cassia*,—no small part of the genus, the much desired monograph of which, prepared two years ago by Mr. Bentham, is probably now in press. A. G.

2. *Popular Names of British Plants.*—Dr. Prior has brought out a second edition (Williams & Norgate, 1870) of this very interesting volume, with many additions or emendations. It is a treasury of curious lore, philological, antiquarian, and botanical, by one thoroughly fitted on every side for the handling of these topics. An alphabetical list of the systematic names of those British plants which have popular appellations is annexed, and under which these are enumerated. A notice of the first edition was published in this Journal, for May, 1864. One can hardly resist the temptation to make extracts from the more curious articles. A. G.

3. *Les Fleurs de Pleine Terre*, etc., par Vilmorin-Andrieux (Paris, 1870), which in the midst of terrible times has passed to a third edition, now rivals in bulk the portly *Bon Jardinier*, filling as it does 1563 duodecimo pages, illustrated by 1300 wood engravings. These, moreover, are separately issued in an *Atlas des Fleurs*, and of this an edition in English is published, forming a handsome and very useful volume. The miniature representations, sometimes of a blossom or flowering branch, commonly of the whole plant, exhibiting its port, are wonderfully effective. A. G.

4. *A Synopsis of all the known Lilies*, by Mr. Baker, one of the assistant botanists at Kew, and author of an important paper on *Liliaceæ* which was recently noticed in this Journal, is in course of publication in the Gardeners' Chronicle, London. This standard horticultural periodical, we may remark, keeps up well its scientific character, and has many interesting botanical articles and memoranda. A. G.

5. *On the Forms and Distribution over the World of the Batrachium section of Ranunculus;* by W. P. Hiern, M.A. Reprinted and revised from the Journal of Botany, 1871. With two plates.—An unusually thorough paper, maintaining the view that these plants, "considering the intricate network of connecting links that seem to break down specific characters in several di-

rections," are most philosophically regarded as forms of one aggregate species. The author adopts for this the name of *R. hydrocharis* Spenner (1829); but he certainly should have retained one of the Linnæan names, the most appropriate one of *R. aquatilis*. He proceeds to arrange and describe the *subspecific* forms, admitting 35, all but one of which bear old names. The exception is *R. Lobbii*, from California, one of the *hederaceus* group, and indicated as a variety of that species by Dr. Torrey in the Botany of Whipple's Expedition. The genuine *R. hederaceus* has recently been detected by the late Mr. Munn, near Norfolk, Virginia, in fresh-water marshes, having all the appearance of being indigenous. Mr. Hiern states that it occurs in North America, but does not say where. A. G.

6. *The Rhododendron, and "American Plants;"* by EDWARD SPRAGUE RAND, Jr. Boston: Little, Brown & Co. 1871. pp. 187, 12mo.—One of those small and neat practical books, very handsomely printed, which are so attractive; and with reason, as conveying the information which the amateur cultivator needs, in a pleasant and readable form, free from all technicalities, and indeed from all scientific details. And the author writes not only *con amore*, but from abundant knowledge of Rhododendron lore and culture. So great is his success that he can affirm that Rhododendrons may be grown in New England "as easily as lilacs;" but, as subsequently qualified, only by those who will take the requisite pains in the first instance. A. G.

## V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Ventilation of Soldiers' Quarters. Special report of Acting Assistant Surgeon* B. F. CRAIG, *United States Army*—appendix to the Surgeon General's "Circular No. 4."—Dr. Craig has made a valuable contribution to our knowledge of the general subject of ventilation by his researches made at certain military posts, the details of which are given in his "Special Report" to General Barnes. We have compiled from this paper the accompanying tabular statement of Dr. Craig's results in a form convenient for reference. Dr. Craig places but little reliance on the determinations of animal matters emanating from the human body, seeing "they are so small in actual mass and of so complex and indefinite a character, that they evade to a certain extent, the powers of chemical titration." He therefore confines himself chiefly to the determination of carbonic acid (Pettenkofer's method, modified slightly) and the measurements of hygroscopic moisture, temperature, &c.

The quantity of carbonic acid in air is increased about one hundred times in passing through the lungs, or from about four parts in 10,000 to four parts in one hundred of air. Mr. Edward Smith's experiments have shown that a sleeping man produces about four-tenths of a cubic foot of carbonic acid per hour, and will therefore increase the amount of it in 1000 cubic feet of air to

*Tabular Statement of Experiments on Ventilation and Composition of Air in Military Barracks, made by Assistant Surgeon B. F. Craig, U. S. Army, prepared from his Report to Surgeon General Barnes.*

| Experiment. | Time of observation. | Tempt. Fh. | | Grains moisture in 1 cubic ft. of | | Apartment. Capacity in cubic ft. | Contents. | | | Estimation of $CO_2$ in 10,000 volumes of | | | Hourly ventilation per man in cubic ft. | Total hourly discharge of air in cubic ft. | Mode of ventilation adopted. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Inner air. | Outer air. | Inner air. | Outer air. | | Men. | Floor space pr. man. | Cubic ft. air per man. | Outer air. | Inner air. | Differ. = contamination. | | | |
| 1 | 12.30 night, Oct. 5, '70. | 69° | 63° | ---- | --- | Casemate, Fort Adams, 10,700 ft. | 15 | 65 | 713 | 4·08 | 9·67 | 5·59 | 474 | 7,110 | Open doors, &c., in summer, stove and flues in winter. |
| 2 | 4 A. M., Oct. 6, '70. | ---- | ---- | ---- | ---- | Same apartment. | 15 | 65 | 713 | 4·08 | 10·07 | 5·99 | 526 | 7,890 | Same. |
| 3 | After midnight, Oct. 13–14. | 70° | 57° | 4·62 | 3·56 | Casement in Fort Independence, Boston, 3,927 ft. | 9 | 39·61 | 436 | 3·68 | 7·18 | 3·50 | 997 | 8,973 | Same. |
| 4 | After midnight, Oct. 14–15. | 70° | 52°·5 | 4·29 | ---- | Casemate, Fort Warren, Boston, 8,100 ft. | 11 | 49 | 540 | 5·49 | 6·26 | 0·77 | 4,950 | 54,450 | Stove and open windows. |
| 5 | Same. | 72° | 52°·5 | 4·76 | 3·41 | Do. do. | 10 | 54 | 540 | 5·49 | 8·37 | 2·88 | 1,200 | 12,000 | Similar. |
| 6 | No date. | 59°·5 | ---- | 3·75 | ---- | Casemate in Fort Wood, N. Y. harbor, 15,860 ft. | 14 | 96 | 1,132 | 4·02 | 5·12 | 1·10 | 7,620 | 106,700 | Fire. |
| 7 | No date. | 58° | 47°·5 | 4·02 | 3·29 | Similar to 6. | 40 | 33 | 396 | 4·62 | 9·13 | 4·51 | 767 | 30,700 | No fire. |
| 8 | No date. | 70° | 47° | 4·07 | 2·60 | Frame barracks, Fort Wadsworth, 21,870 ft. | 15 | 145 | 1458 | 4.23 | 6·24 | 2·01 | 1,514 | 22,710 | 3 chimneys and 2 fires. |
| 9 | No date. | ---- | ---- | ---- | ---- | Casemate, Fort Fort Hamilton, N. Y., 7,700 ft. | 18 | 34 | 428 | 4·22 | 14·06 | 9·84 | 260 | 468 | Useless. |
| 10 | ---- | ---- | ---- | ---- | ---- | Old frame barracks, Willett's Point. | 28 | 58 | 780 | 2·96 | 4·96 | 1·90 | 780 | 21,640 | Open slits at eaves and stoves. |
| 11 | ---- | ---- | ---- | ---- | ---- | Willett's Point. Similar to last. | 11 | ---- | 1,500 | ---- | 10·67 | ---- | 25 | 275 | Nothing. |

the extent of four parts in 10,000, and in 2000 feet to the extent of two parts in 10,000, &c. So that from the percentage of carbonic acid we may infer, by computation, the number of cubic feet of fresh air received per hour for each man. Of course an allowance is to be made for the amount of air originally contained in the room, and this is to be determined on obvious principles, by considering the size of the room, the number of its occupants, and the length of time during which it had been occupied by them when the air was collected. Dr. Craig describes in detail the precautions taken by him to secure accuracy in the use of the methods of determination employed in his experiments, the results of which are condensed into the annexed table.

Dr. Craig's remarks with regard to the general results of his examinations, that the amount of air which writers on hygiene have held to be the minimum supply consistent with perfect healthfulness, viz. 2000 cubic feet per man per hour, was in most of the cases attained only in exceptional cases, while in some of the instances cited the deficiency is excessive.

The amount of good scientific work which has been undertaken and is still in progress in connection with the Surgeon General's office is highly creditable to the gentlemen in charge. The microscopic labors of Dr. Woodward in connection with the Army Medical Museum are already familiar to our readers. The enormous collections of morbid anatomy and surgery, preserved in the most methodical and orderly manner in the museum itself, are in process of description in many volumes of text with illustrations, parts of which are already issued. B. S.

2. *Reports of the United States Commissioners to the Paris Universal Exposition*, 1871. Published under the direction of the Secretary of State, by authority of the Senate of the United States; edited by WM. P. BLAKE, Commissioner of the State of California.—Mention of the various reports included in this series has been made in this Journal, as they have appeared. They have recently been issued in six handsome octavo volumes. The reports, the work of many able authors, contain a large amount of valuable matter on a wide range of topics, and have been well edited by Mr. Blake. The first volume contains an index to all the reports.

3. *Associations for the Advancement of Science.*—The next meeting of the British Association opens at Edinburgh on August 2d, and of the American, at Indianapolis, Indiana, on August 17th. Prof. Wm. Thomson is president of the former, and Prof. Asa Gray, of the latter.

## OBITUARY.

CHARLES MAYER WETHERILL, Ph.D., M.D., died suddenly of heart disease, on the morning of March 5th, at his residence in the grounds of the Lehigh University, South Bethlehem, Pa.

Dr. Wetherill was born in Philadelphia, 4th Nov., 1825, where he graduated with first honors in the University of Penn., in 1845. In 1846 he worked at practical chemistry in the laboratory of Booth and Boyé, and during 1847 he passed eight months with

Pelouze in Paris. Thence he proceeded in Nov. 1847, to the then world-renowned teachings of Liebig, at Giessen, and there graduated Ph.D., in May, 1848. The years 1849–50–51–52, were spent in chemical investigations in his private laboratory in Philadelphia, and in giving courses of chemical lectures before the Franklin Institute. He subsequently held no public position until his election in July, 1862, to the position of chemist of the Agricultural Department of the Patent Office, which post he occupied until Oct., 1863. In 1866 he was elected to the chair of chemistry in the Lehigh University, which office he held at the time of his death.

Dr. Wetherill was a member of the American Philosophical Society, and of the Academy of Natural Sciences of Philadelphia, and of the Geological Society of Vienna. In 1853, the degree of M.D. was conferred upon him by the N. Y. Medical College.

A man of science, as such, writes his own eulogy in his works, in which alone will he live beyond the memory of his associates; and in the annals of American science Wetherill will be known when the names of many of greater temporary éclat will have been dropped from the records. He was essentially a man of work, and the list of his researches will show how honestly he devoted himself to his science, and strove—as all true men of science will strive,—to bring within the bounderies of the known, some of the extended region of possibilities and of conjectures. His title to such conquests will chiefly rest on his paper, "*Ueber neutrales schwefelsaures Aethyloxyd und dessen Zersetzungsproducte mit Wasser,*" An. der Ch. und Pharm., lxvi, 117, and Proc. Amer. Phil. Soc., 1848, and in his "*Experiments with the Ammonium Amalgam,*" Amer. Jour. Sci., 1865 and 1871.

Innately truthful as a man and conscientiously faithful in all he undertook, the body of his work will, we are bold to hope, stand the tests of the revision of more searching methods which will be added in the advance of knowledge. Another trait of Dr. Wetherill's character was a steady, systematic execution of his work, generally founded on plans which he had previously matured by viewing on all sides. He leaves in the Lehigh University laboratory a monument of himself, and no one can visit that institution and walk through those beautifully equipped rooms without seeing the mental characteristics which we have mentioned.

In his death science mourns the loss of a faithful servant, and friendship casts upon his grave this tribute,—in heartfelt recognition of his worth. A. M. M.

**Herschel**, the Astronomer, died on the 12th of May, at the age of seventy-three.

**Becquerel.**—M. Becquerel, who recently died in France, was not the physicist, but his son, Dumeril Becquerel.

Geological Survey of Canada; Alfred R. C. Selwyn, Director. Report of Progress from 1866 to 1869. 476 pp. 8vo, accompanied by Geological and Topographical maps. Montreal: Dawson Bros. (B. Westermann, New York).

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